

Daily report

31-05-2020

## Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

## Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓  $\alpha$ : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓  $K$ : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

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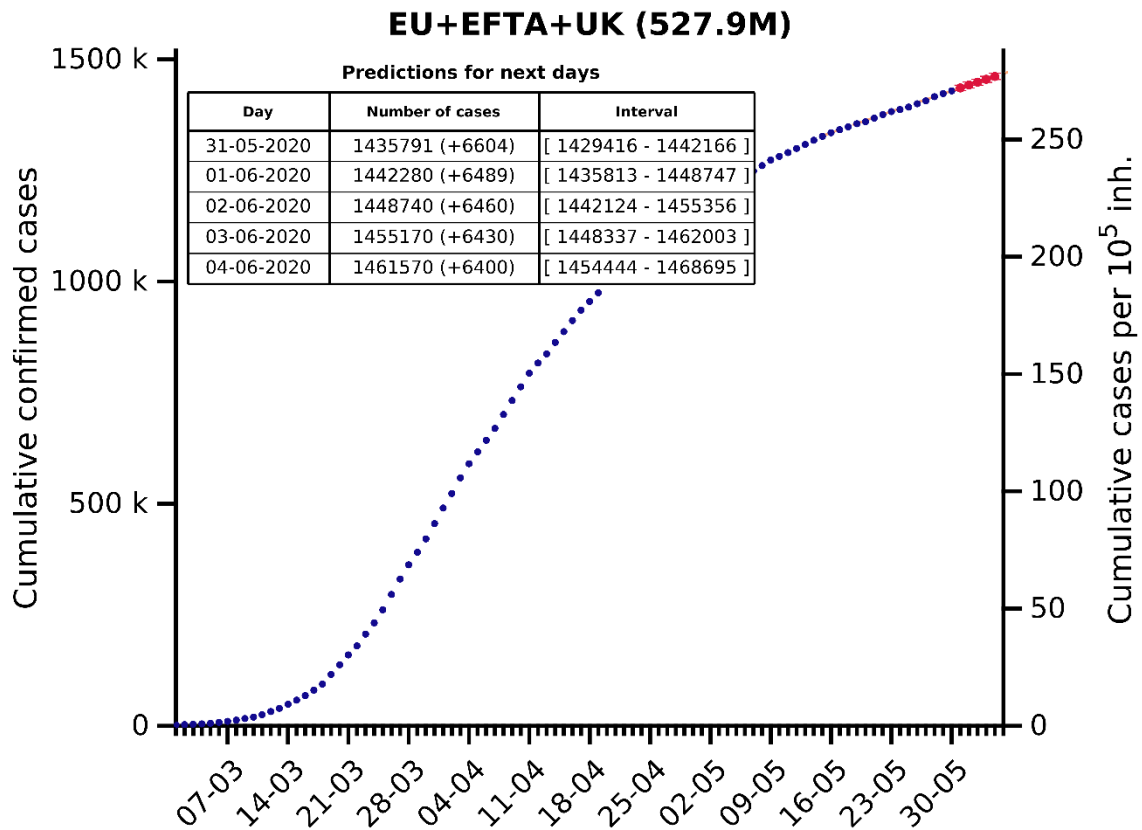


## **(0) Executive summary – Dashboard**

## Weekend short version

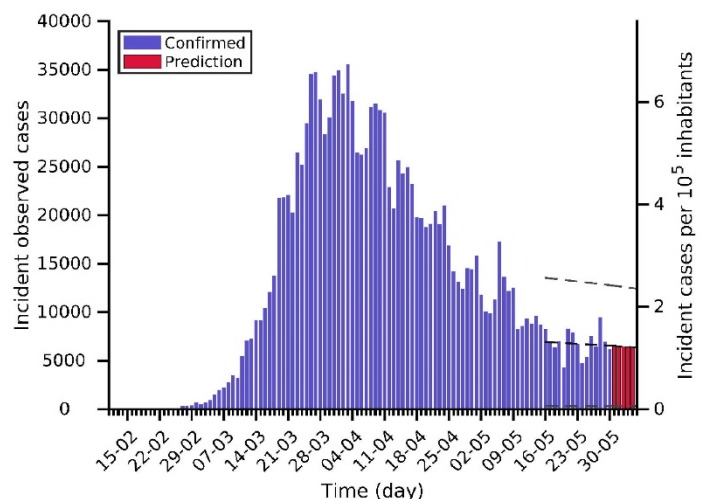
### Attack rate and short-term predictions in EU+EFTA+UK

Short-term predictions, based on last 15 points with increased weight on last 3:



### Highlights and/or warnings

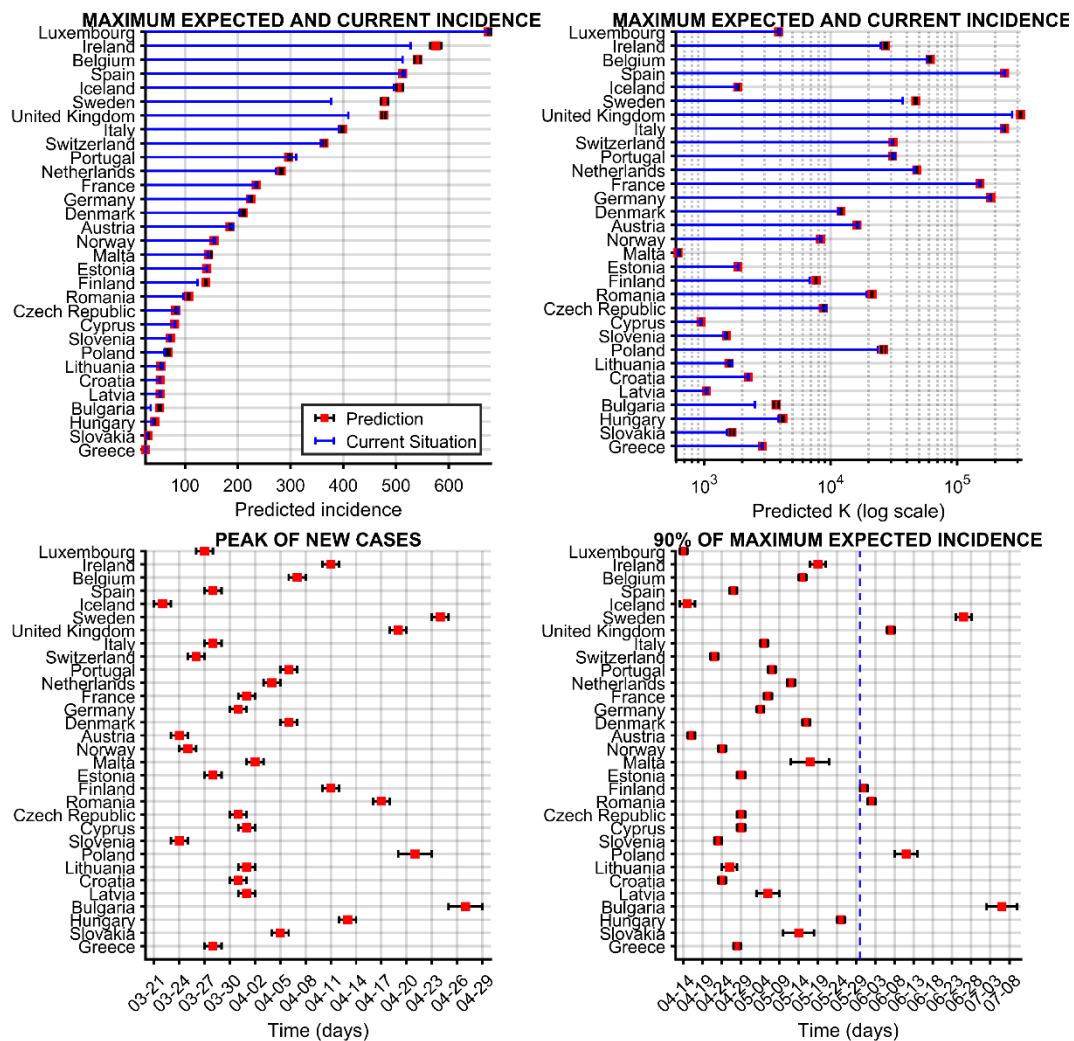
- UE+EFTA+UK new cases are shown in the figure. They are situated at the level of 6,500 new cases daily.
- European  $\rho_7$  is slightly above the threshold of 1.
- High  $\rho_7$  in Spain and France is caused by problems on reporting. France shows a new spike.
- Other European countries follow the trend of previous days.



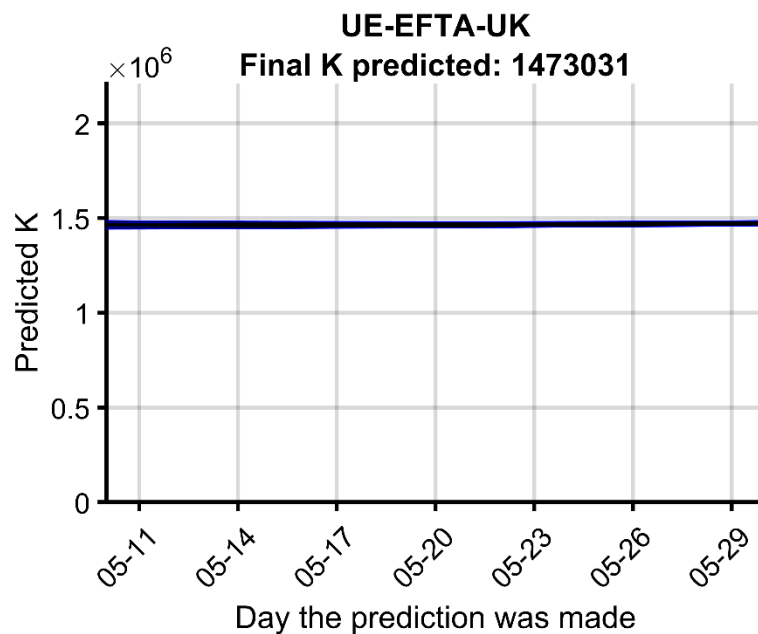
### Long-term predictions

**Long-term predictions**, evaluated with the **whole historical series**. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per  $10^5$  inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current

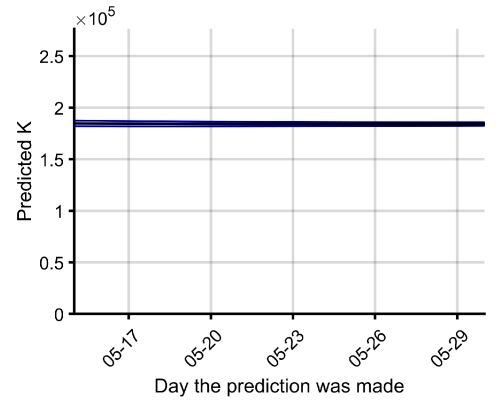
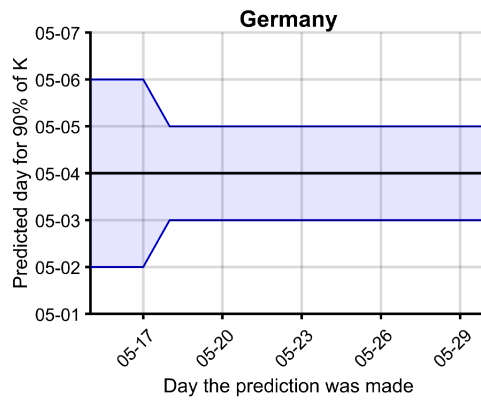
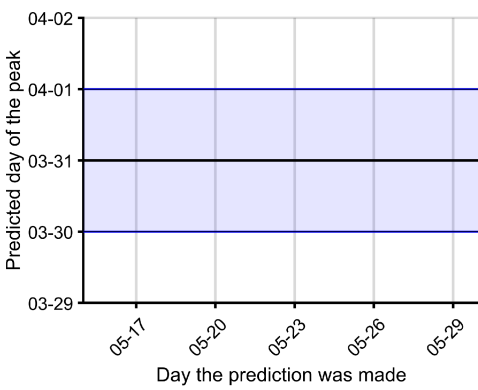
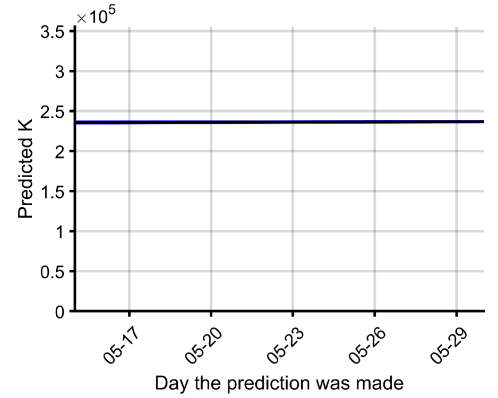
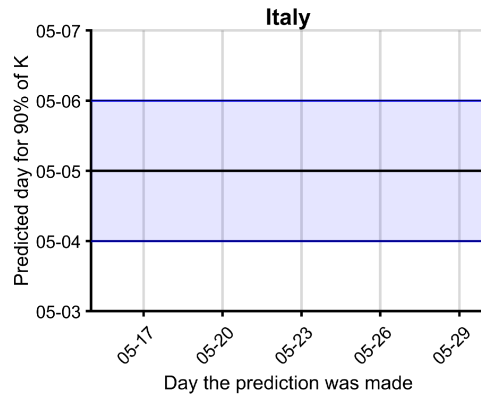
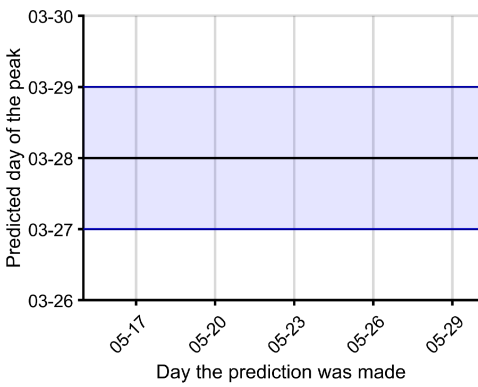
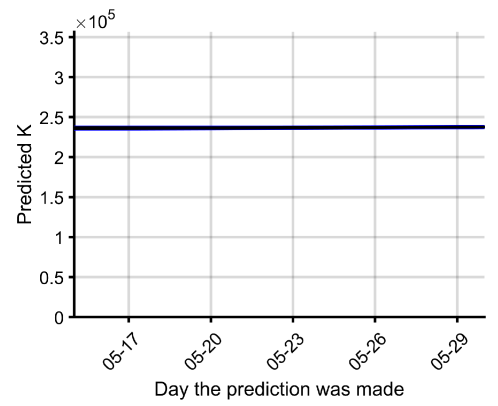
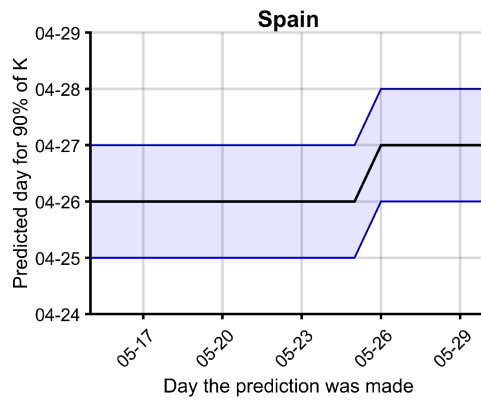
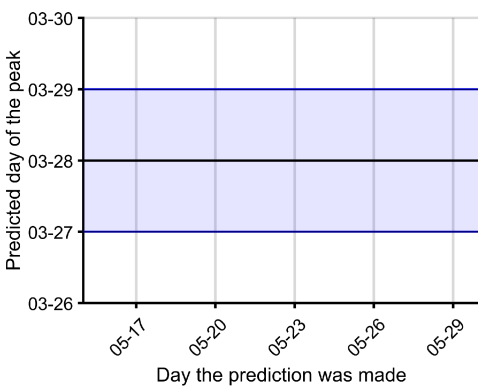
situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



**Final expected K** for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown.

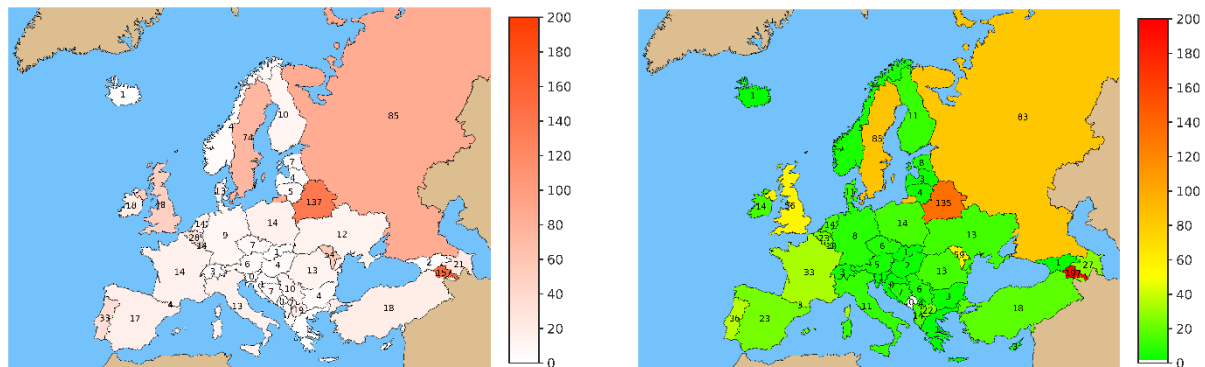


2020-05-30



## Situation and trends per country

**Maps.** The map in the left shows current  $A_{14}$ . The map in the right shows current EPG.



**Table** of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables.  $EPG_{REP}$  and  $EPG_{EST}$  **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data								Indexes		
	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10 <sup>5</sup> inh.	$\rho_7^{(1)}$	$EPG_{REP}^{(2)}$	$EPG_{EST}^{(3)}$
United Kingdom	272,826	410.6	38,376	57.8	32,665	49.2	474,367	698.8	1.16	57	812
Spain	239,228	516.2	27,125	58.5	8,530	18.4	98,193	208.8	1.69	31	352
Italy	232,664	391.5	33,340	56.1	7,904	13.3	115,492	191.0	0.81	11	156
Germany	181,482	221.5	8,500	10.4	7,127	8.7	35,128	41.9	0.91	8	38
France	151,496	234.1	28,771	44.5	9,205	14.2	184,433	282.6	2.35	33	663
Belgium	58,186	512.3	9,453	83.2	3,197	28.1	53,318	460.0	0.85	24	390
Netherlands	46,257	272.3	5,951	35.0	2,387	14.1	31,449	183.5	1.02	14	187
Sweden	37,113	377.2	4,395	44.7	7,436	75.6	96,779	958.3	1.15	87	1,106
Portugal	32,203	310.5	1,396	13.5	3,393	32.7	15,606	153.1	1.08	35	166
Switzerland	30,762	358.9	1,656	19.3	273	3.2	1,564	18.1	0.94	3	17
Ireland	24,929	527.5	1,651	34.9	881	18.6	5,996	121.4	0.77	14	93
Poland	23,571	61.7	1,061	2.8	5,314	13.9	26,432	69.8	0.97	13	67
Romania	19,133	96.7	1,253	6.3	2,429	12.3	17,048	88.6	1.05	13	93
Austria	16,638	191.0	668	7.7	498	5.7	2,139	23.7	0.83	5	20
Denmark	11,633	203.7	571	10.0	775	13.6	3,885	67.1	0.82	11	55
Czech Republic	9,230	87.0	319	3.0	775	7.3	2,871	26.8	0.83	6	22
Norway	8,411	156.7	236	4.4	214	4.0	602	11.1	1.23	5	14
Finland	6,826	124.0	316	5.7	540	9.8	2,712	48.9	1.11	11	54
Luxembourg	4,016	697.2	110	19.1	86	14.9	234	37.4	0.70	10	26
Hungary	3,867	39.6	524	5.4	358	3.7	5,141	53.2	0.65	2	35
Greece	2,915	26.1	175	1.6	96	0.9	596	5.7	0.91	1	5
Bulgaria	2,513	35.2	140	2.0	302	4.2	1,838	26.5	0.73	3	19
Croatia	2,246	53.3	103	2.4	22	0.5	101	2.5	0.48	0	1
Estonia	1,865	142.1	67	5.1	95	7.2	NA	NA	1.05	8	NA
Iceland	1,806	495.8	10	2.7	4	1.1	NA	NA	0.86	1	NA
Lithuania	1,670	57.4	70	2.4	136	4.7	NA	NA	0.72	3	NA
Slovakia	1,521	27.9	28	0.5	28	0.5	NA	NA	1.77	1	NA
Slovenia	1,473	70.9	108	5.2	7	0.3	53	2.5	2.00	1	5
Latvia	1,065	54.0	24	1.2	68	3.5	NA	NA	0.88	3	NA
Cyprus	943	80.6	17	1.5	29	2.5	NA	NA	1.21	3	NA
Malta	616	143.6	7	1.6	70	16.3	NA	NA	NA	NA	NA
Liechtenstein	83	215.3	1	2.6	0	0.0	NA	NA	NA	NA	NA
Scale											
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	100	1000
Best	Best	Best	Best	Best	Best	Best	Best	Best	0.0	0	0

<sup>(1)</sup>  $\rho_7$  is the average of 7 consecutive  $\rho$ , but can still fluctuate. <sup>(2,3)</sup> EPG stands for Effective Growth Potential.  $EPG_{REP}$  is obtained by multiplying attack rate of last 14 days per 10<sup>5</sup> inhabitants (i.e. density of cases) by  $\rho_7$  (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days).  $EPG_{EST}$  is obtained by multiplying estimated real attack rate of last 14 days per 10<sup>5</sup> inhabitants by  $\rho_7$ .

**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1 % (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher).

## Situation and trends in other countries

**Table** of current situation in a sample of non-EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. EPG<sub>REP</sub> and EPG<sub>EST</sub> **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

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	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10 <sup>5</sup> inh.	$\rho_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>
United States of America	1.770.384	534,9	103.781	31,4	302.500	91,4	1.900.451	574,1	0,95	87	545
Brazil	498.440	234,5	28.834	13,6	265.298	124,8	1.958.254	921,3	1,19	149	1.099
Russia	396.575	271,7	4.555	3,1	124.532	85,3	NA	NA	0,97	83	NA
India	182.143	13,5	5.164	0,4	91.216	6,7	309.552	22,9	1,15	8	26
Peru	155.671	472,1	4.371	13,3	67.130	203,6	226.335	686,4	1,31	267	899
Iran	148.950	177,3	7.734	9,2	30.558	36,4	169.109	201,3	0,99	36	199
Chile	94.858	496,2	997	5,2	53.430	279,5	114.204	597,4	1,15	321	687
Canada	90.179	238,9	7.073	18,7	14.326	38,0	128.481	340,4	0,90	34	306
Mexico	87.512	67,9	9.779	7,6	40.368	31,3	575.998	446,7	1,14	36	510
Saudi Arabia	83.384	239,5	480	1,4	31.368	90,1	NA	NA	0,79	71	NA
Pakistan	69.496	31,5	1.483	0,7	29.345	13,3	72.715	32,9	1,02	14	33
Qatar	55.262	1.918,1	36	1,2	24.290	843,1	NA	NA	1,11	939	NA
Belarus	41.658	440,9	229	2,4	12.977	137,3	NA	NA	0,98	135	NA
Ecuador	38.571	218,6	3.334	18,9	5.808	32,9	60.417	342,4	0,76	25	261
Argentina	16.201	35,8	528	1,2	8.409	18,6	53.505	118,4	1,27	24	150

Scale											
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	100
Best	Best	Best	Best	Best	Best	Best	Best	Best	Best	0,0	0

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## Time indicators by country

These tables summarize a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of  $1/10^5$  inhabitants and an attack rate of  $10/10^5$  inhabitants, and time interval between attack rates of 10 to 100 per  $10^5$  inhabitants (only for countries that have overtaken this threshold).

### EU+EFTA+UK countries

Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / $10^5$ inh. (days)	Time interval between 10 and 100 cases / $10^5$ inh. (days)
Italy	98	11	16
Germany	92	12	17
France	91	10	20
Spain	91	8	12
United Kingdom	87	10	12
Belgium	86	11	14
Netherlands	86	11	20
Sweden	86	10	28
Norway	86	2	7
Switzerland	86	8	11
Austria	84	10	14
Denmark	83	4	30
Czech Republic	80	11	NA
Finland	80	12	46
Greece	80	18	NA
Iceland	80	5	15
Portugal	79	9	15
Slovenia	79	6	NA
Estonia	78	5	30
Ireland	78	8	18
Poland	78	17	NA
Romania	78	15	NA
Luxembourg	75	6	7
Slovakia	74	24	NA
Bulgaria	73	30	NA
Croatia	73	12	NA
Hungary	72	20	NA
Latvia	72	12	NA
Lithuania	71	9	NA
Malta	70	9	35
Cyprus	69	12	NA

## Other countries

Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / $10^5$ inh. (days)	Time interval between 10 and 100 cases / $10^5$ inh. (days)
Iran	95	11	42
United States of America	90	8	15
Canada	81	11	27
Qatar	81	3	31
Brazil	78	20	34
Saudi Arabia	77	21	29
Chile	76	13	36
Pakistan	76	35	NA
India	76	38	NA
Russia	75	15	24
Peru	75	18	22
Ecuador	75	10	30
Mexico	74	25	NA
Argentina	73	39	NA
Belarus	62	10	18



# Situation and trends in Italian regions<sup>1</sup>

## Situation and trends

Country	Reported data								Indexes		
	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10 <sup>5</sup> inh.	$\rho_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>
Lombardia	88.968	886,0	16.112	160,4	4.124	41,1	76.314	758,5	0,95	39	721
Piemonte	30.637	703,3	3.867	88,8	1.090	25,0	13.880	318,6	0,82	21	261
Emilia Romagna	27.790	623,2	4.114	92,3	558	12,5	8.408	188,6	0,81	10	153
Veneto	19.152	390,4	1.918	39,1	211	4,3	2.140	43,6	0,60	3	26
Toscana	10.104	270,9	1.041	27,9	156	4,2	1.711	45,9	0,54	2	25
Liguria	9.663	623,2	1.465	94,5	504	32,5	7.754	499,9	0,69	22	343
Lazio	7.728	131,4	735	12,5	282	4,8	2.801	47,7	0,67	3	32
Marche	6.730	441,2	987	64,7	63	4,1	1.017	66,7	0,72	3	48
Campania	4.802	82,8	412	7,1	118	2,0	1.032	17,8	0,88	2	16
Puglia	4.494	111,5	504	12,5	115	2,9	1.292	32,1	0,55	2	18
Trento	4.430	413,1	462	43,1	92	8,6	960	178,4	0,54	5	97
Sicilia	3.443	68,9	274	5,5	55	1,1	438	8,8	0,83	1	7
Friuli Venezia Giulia	3.273	269,3	333	27,4	82	6,7	851	70,0	0,87	6	61
Abruzzo	3.244	247,3	405	30,9	58	4,4	761	58,0	0,49	2	28
Bolzano	2.597	2.417,3	291	270,9	16	14,9	181	34,7	0,54	8	19
Umbria	1.431	162,2	76	8,6	7	0,8	NA	NA	0,20	0	NA
Sardegna	1.356	82,7	130	7,9	3	0,2	34	2,1	NA	NA	NA
Valle d'Aosta	1.184	942,6	143	113,8	11	8,8	130	103,1	1,14	10	118
Calabria	1.158	59,5	97	5,0	7	0,4	NA	NA	0,32	0	NA
Molise	436	142,7	22	7,2	25	8,2	NA	NA	0,59	5	NA
Basilicata	399	70,9	27	4,8	7	1,2	NA	NA	0,79	1	NA

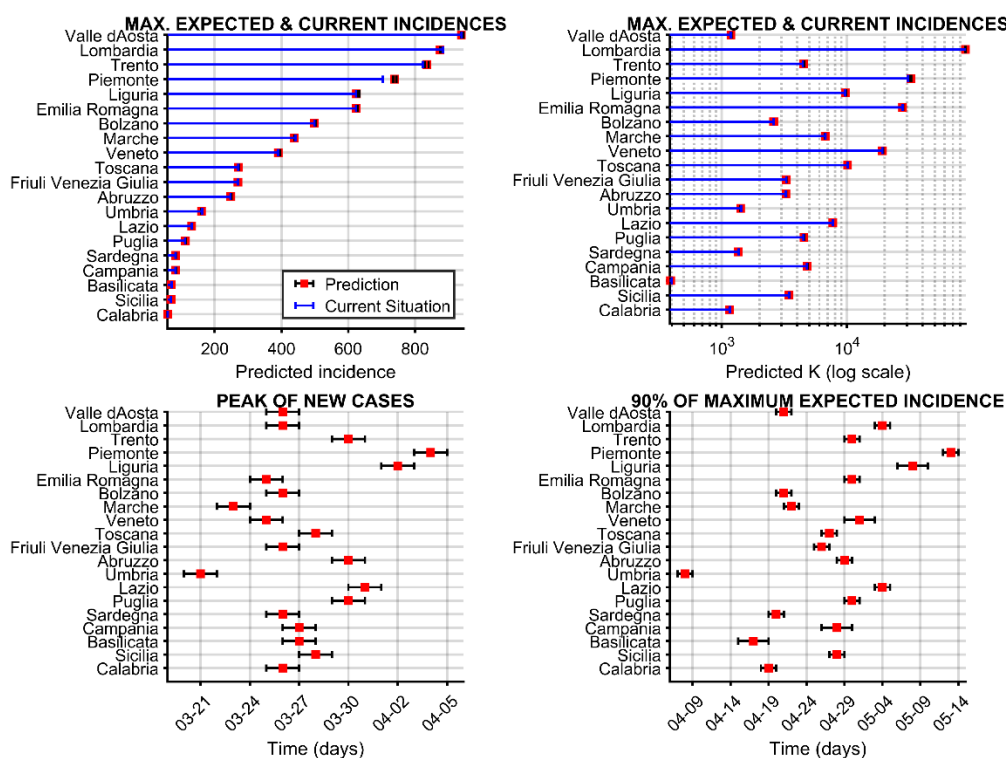
  

Scale											
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	100	1000
Best	Best	Best	Best	Best	Best	Best	Best	Best	0,0	0	0

<sup>(1)</sup>  $\rho_7$  is the average of 7 consecutive  $\rho$ , but can still fluctuate. <sup>(2,3)</sup> EPG stands for Effective Growth Potential. EPG<sub>REP</sub> is obtained by multiplying attack rate of last 14 days per 10<sup>5</sup> inhabitants (i.e. density of cases) by  $\rho_7$  (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG<sub>EST</sub> is obtained by multiplying estimated real attack rate of last 14 days per 10<sup>5</sup> inhabitants by  $\rho_7$ .

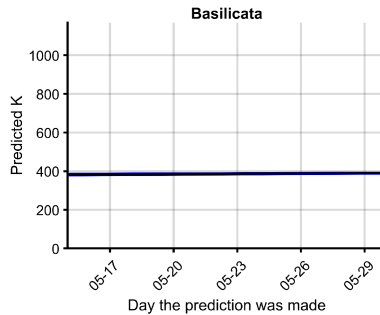
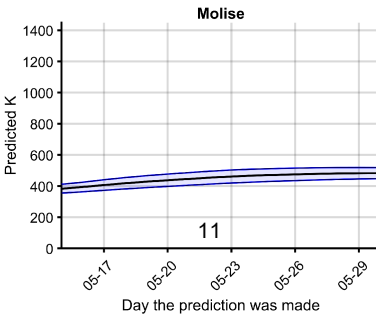
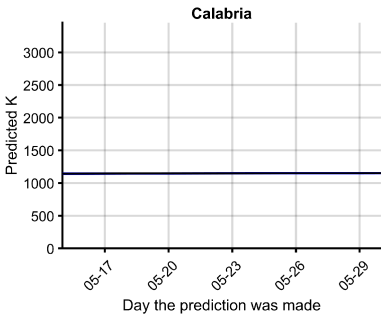
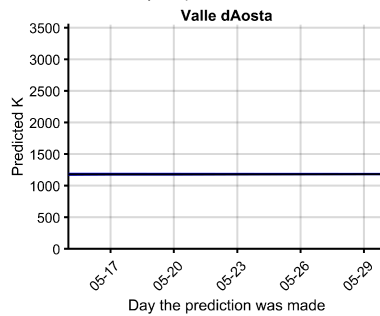
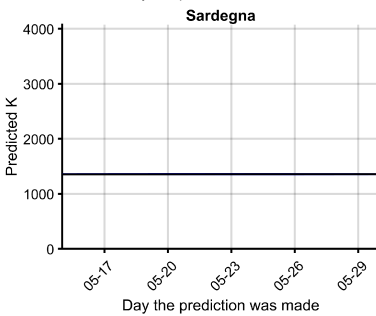
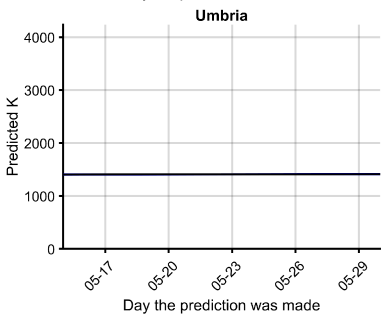
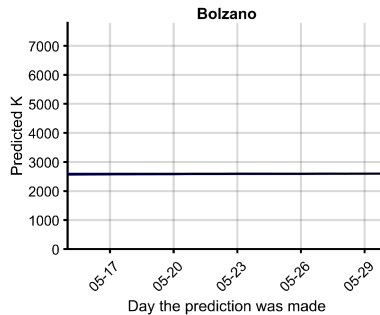
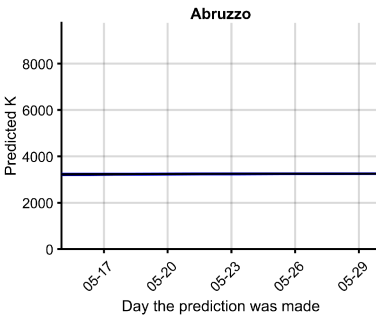
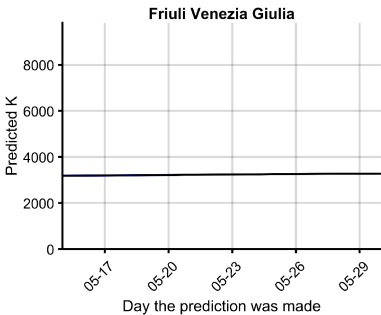
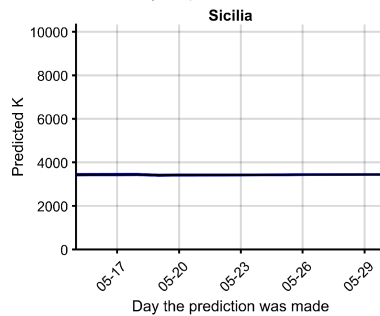
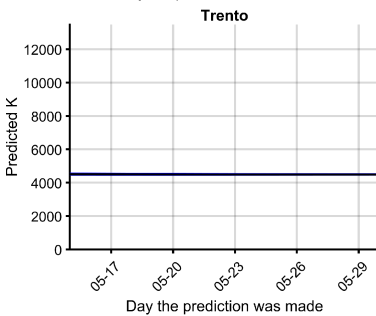
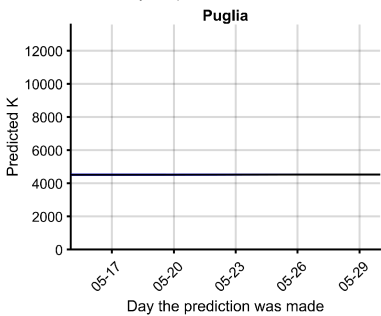
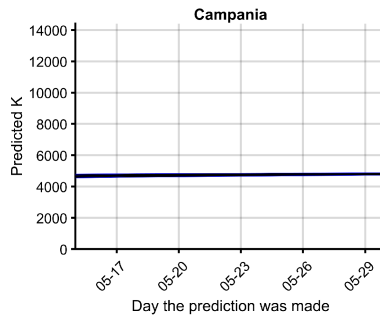
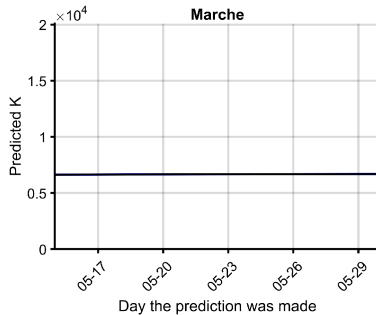
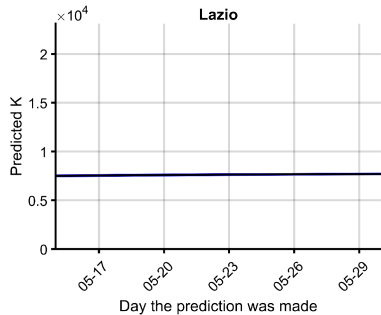
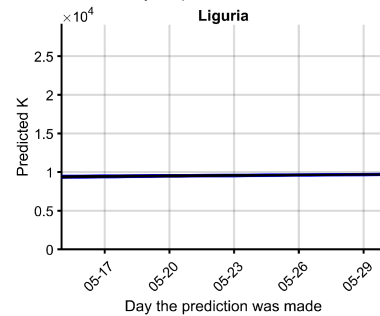
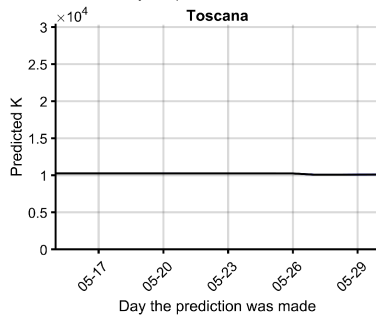
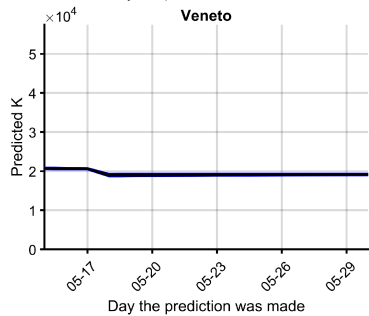
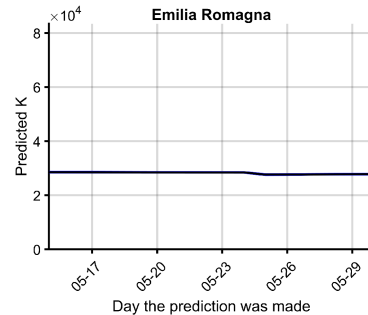
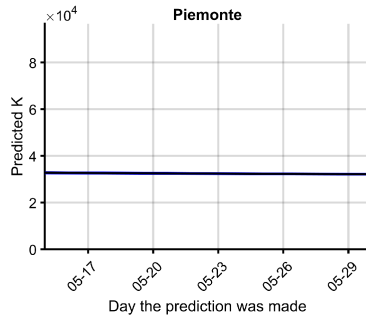
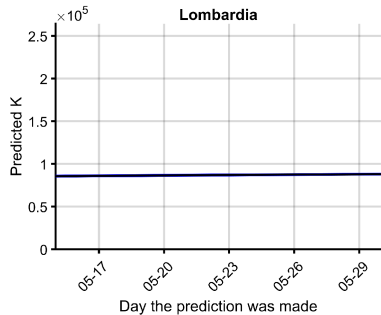
**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1 % (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher).

## Long-term predictions



<sup>1</sup> Spain: Historical series have not been updated. Therefore, regional analysis is not shown

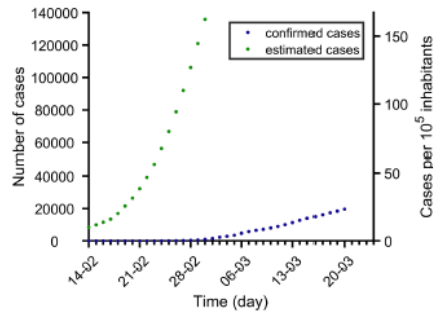
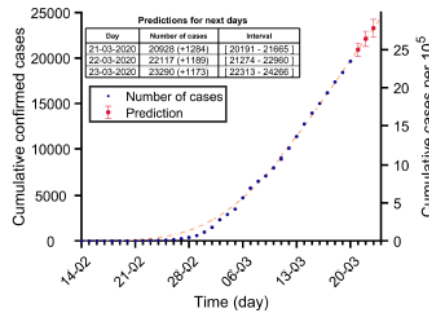
2020-05-31



## Legend: Countries' reports details

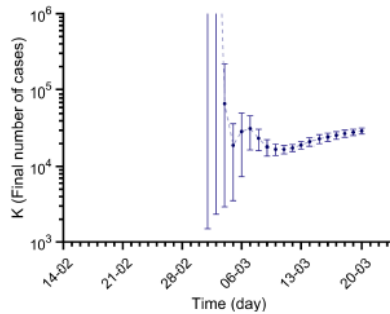
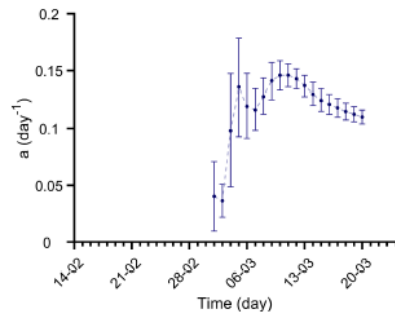
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence:  $23/10^5$

Confirmed cases:  
data (blue),  
model fitted  
(dashed line),  
predictions (red  
points and table)



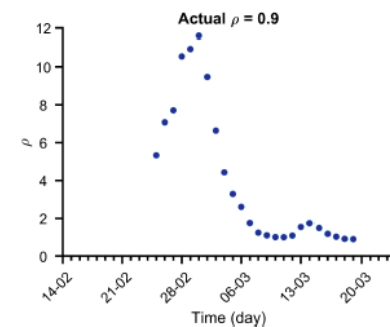
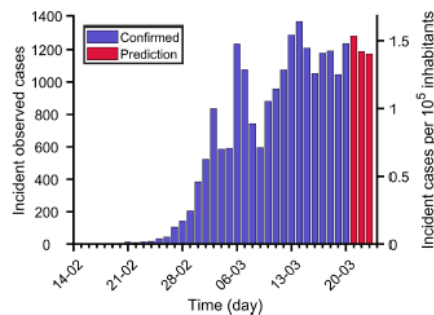
Estimated  
cases using  
death rate (see  
Methods)

Fitted  $a$  value  
using points  
prior to each  
date



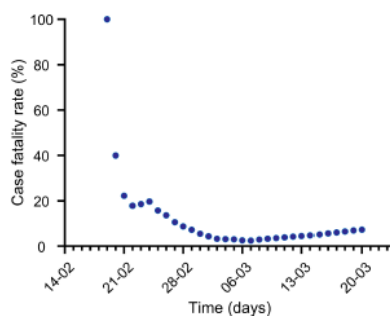
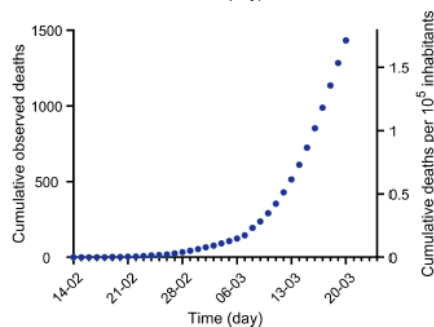
Fitted  $K$  value  
using points  
prior to each  
date

Reported  
and  
predicted  
new cases



Evolution of  $\rho$ , a  
parameter related  
with Reproduction  
number (see  
Methods)

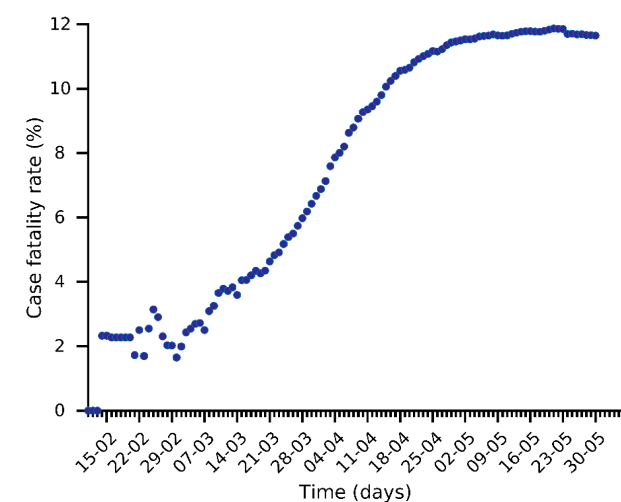
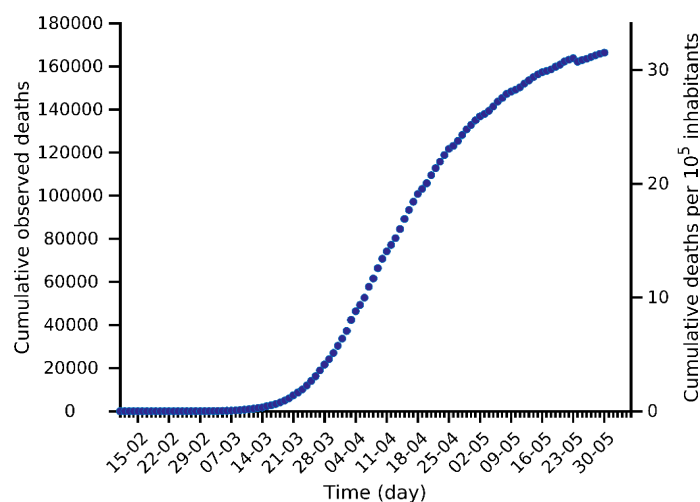
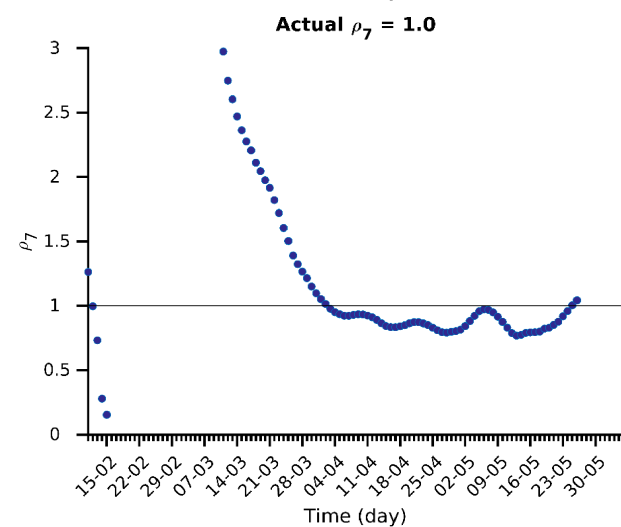
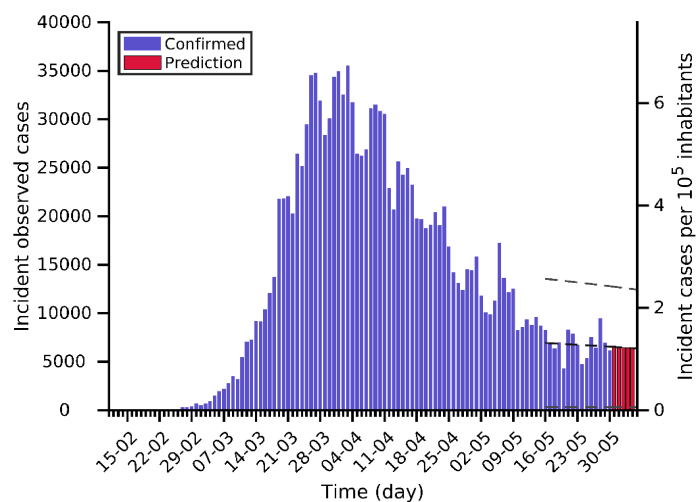
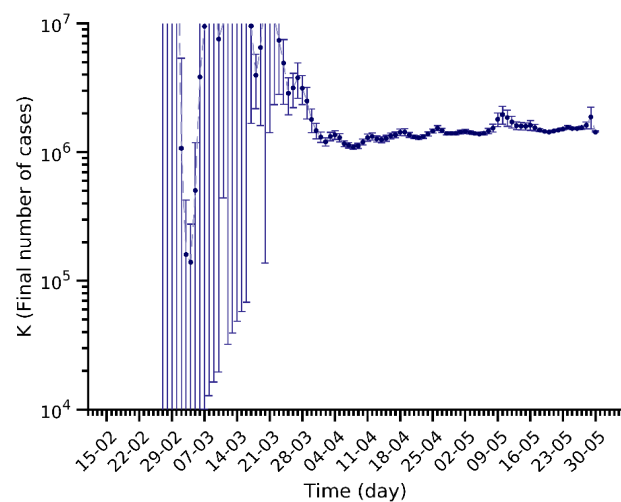
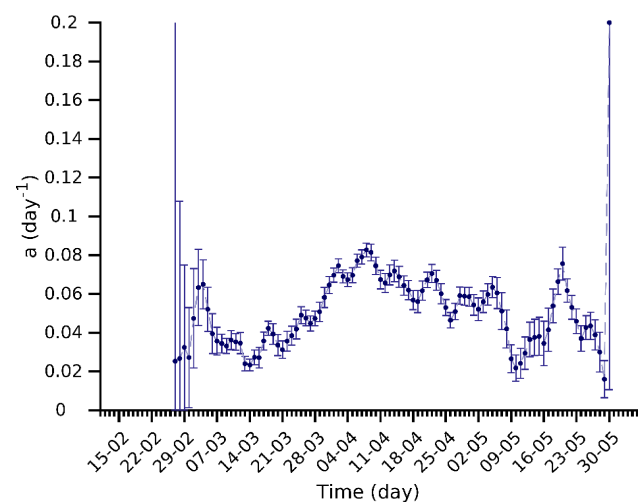
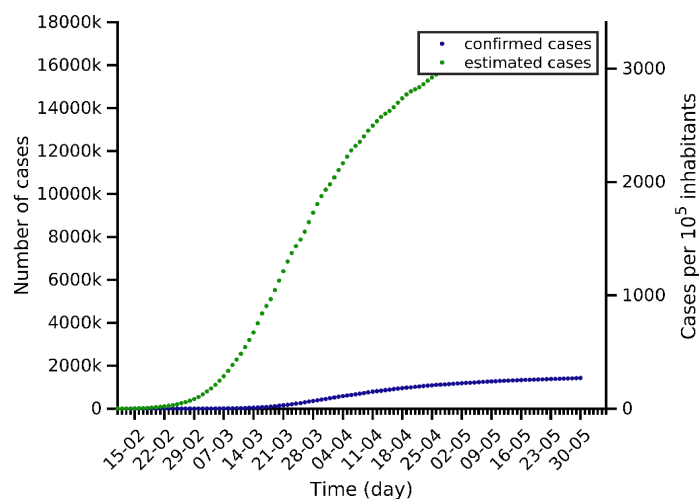
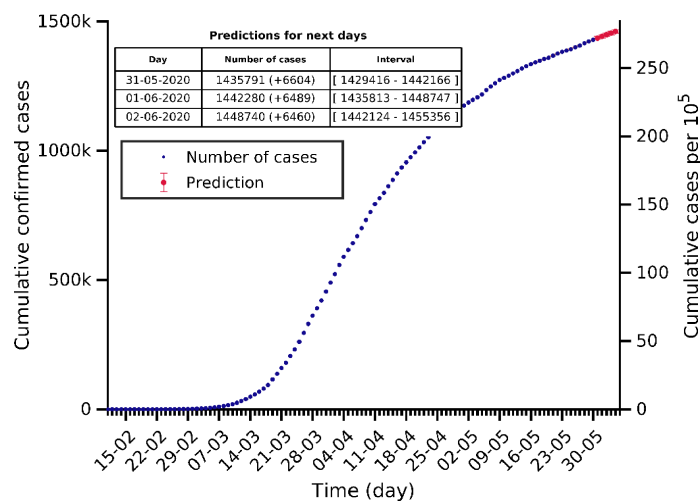
Reported  
deaths



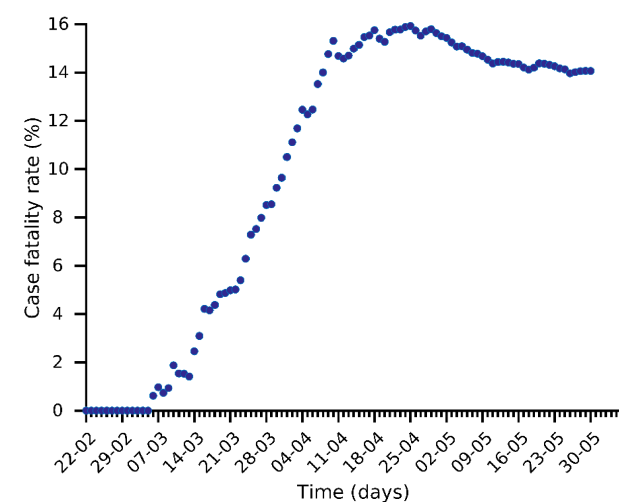
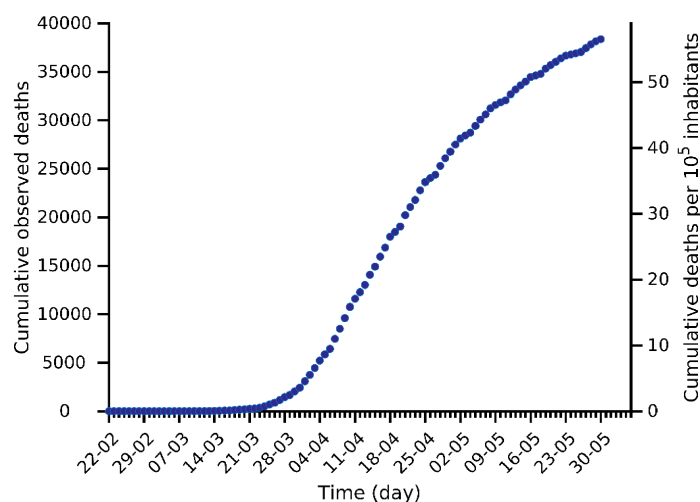
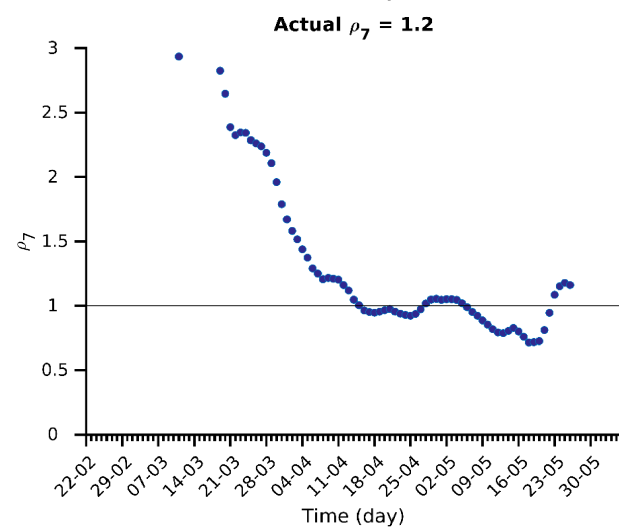
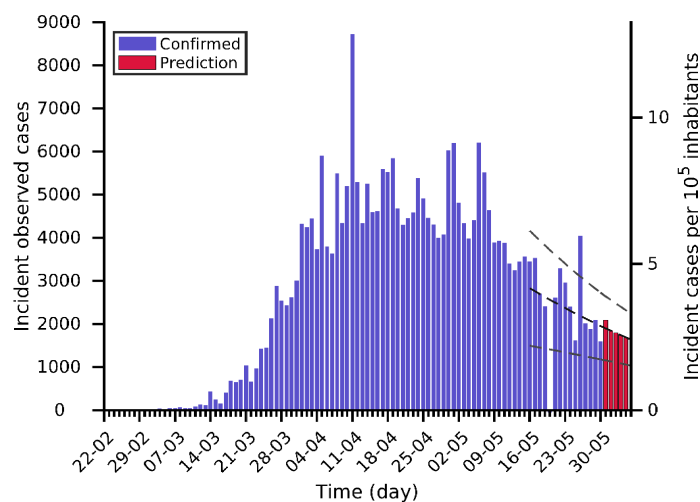
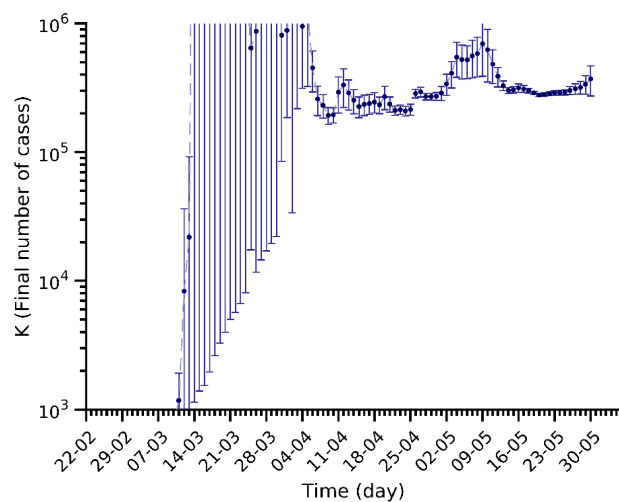
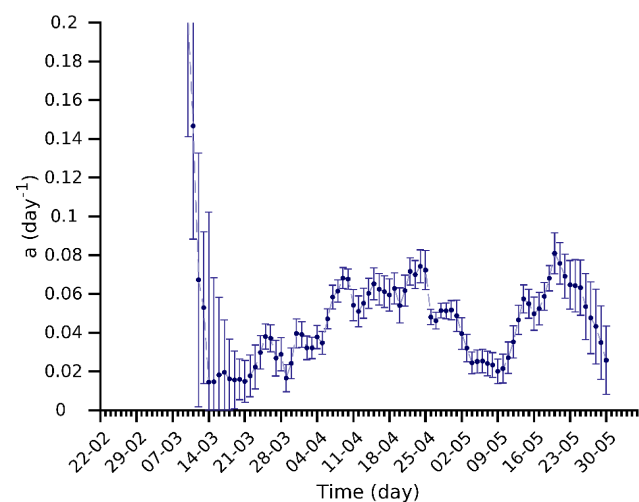
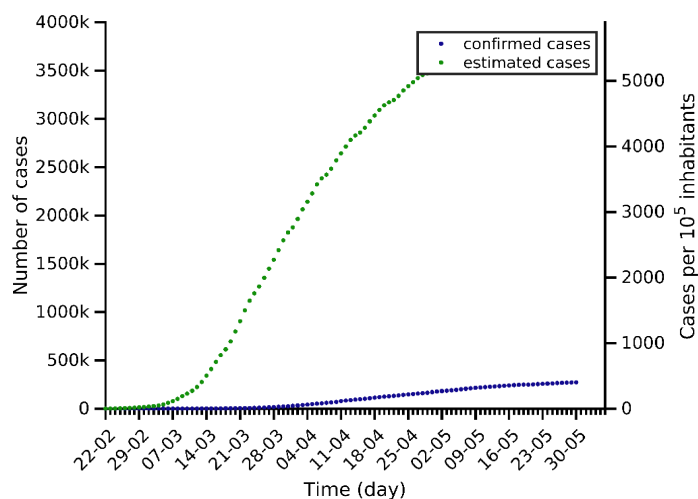
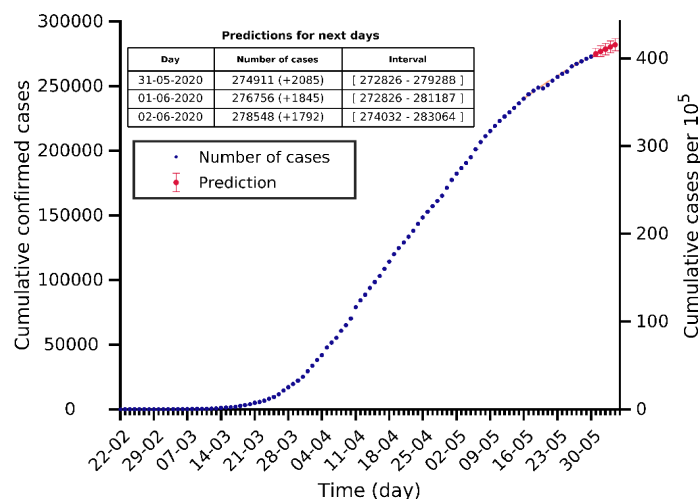
Deaths /  
cumulated  
reported cases

## **(1) Analysis and prediction of COVID-19 for EU+EFTA+UK**

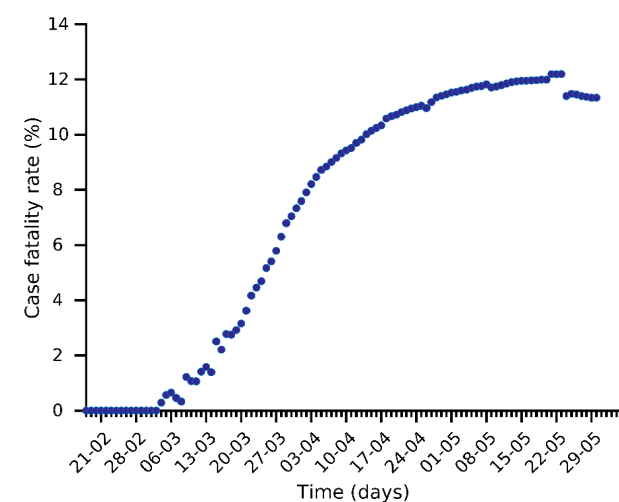
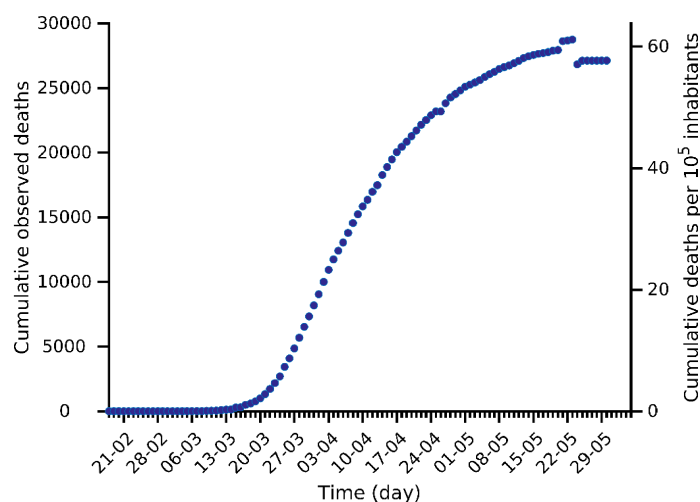
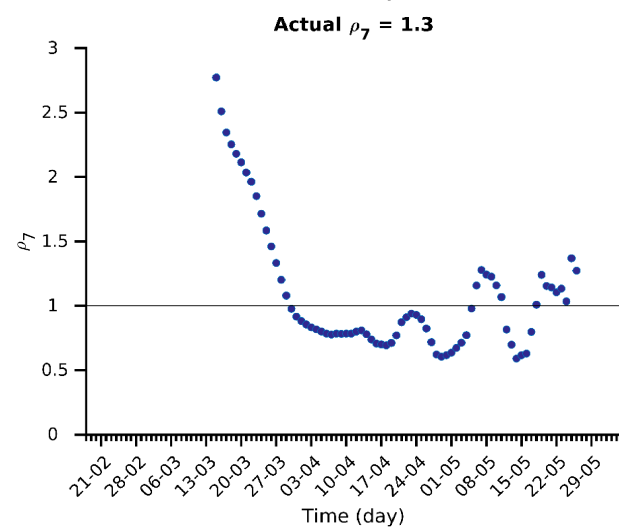
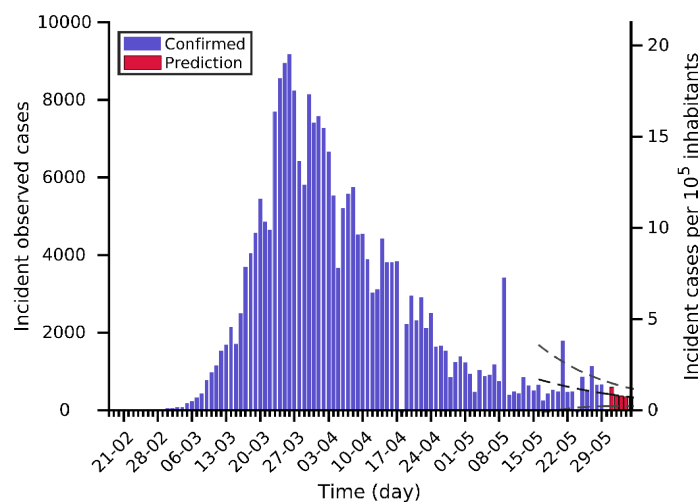
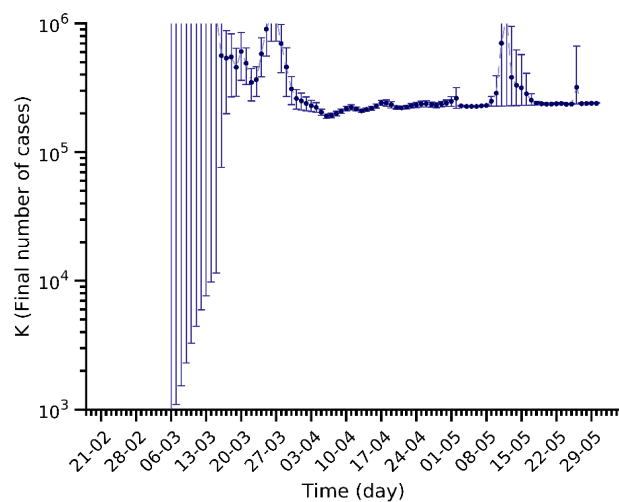
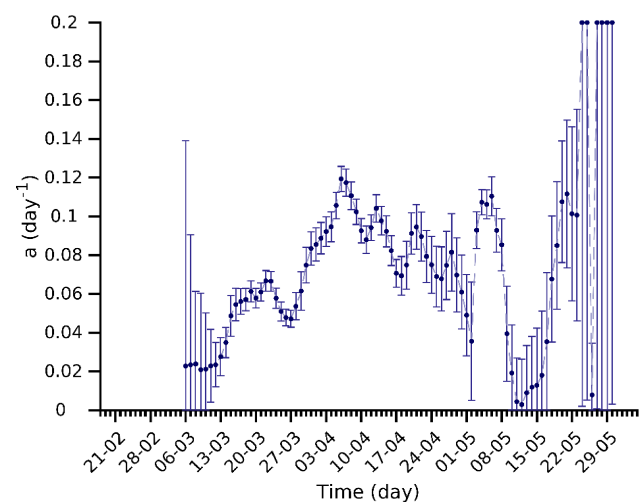
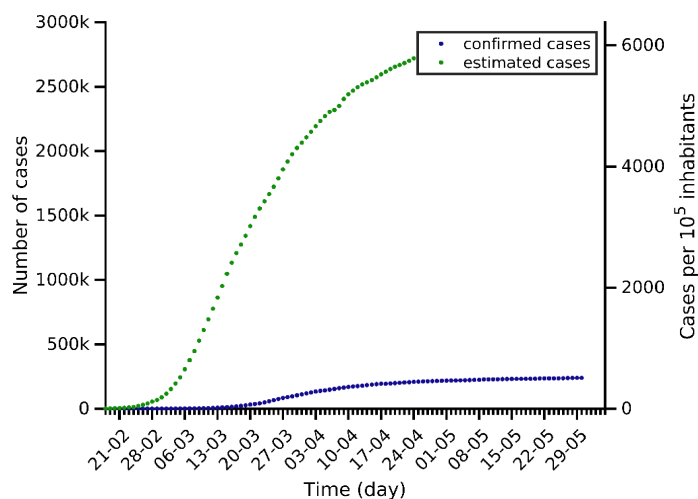
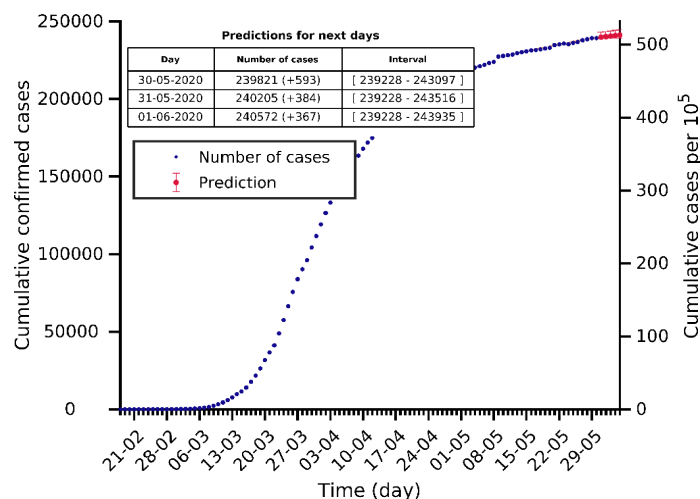
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



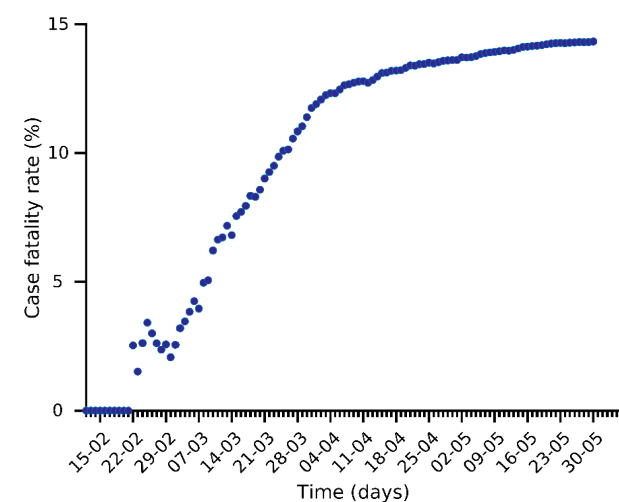
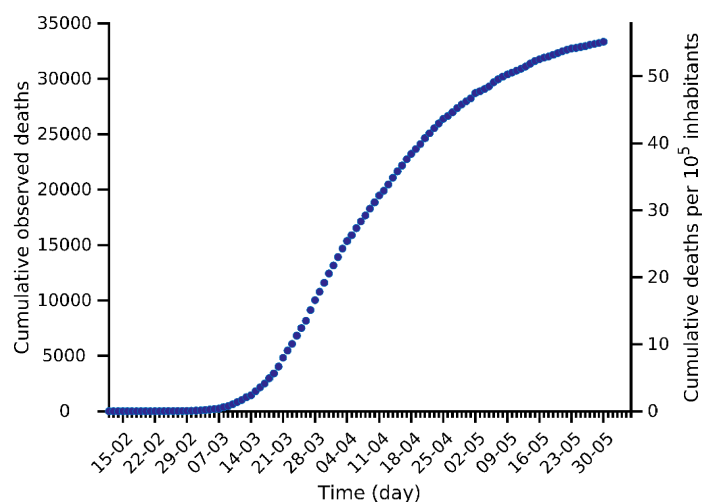
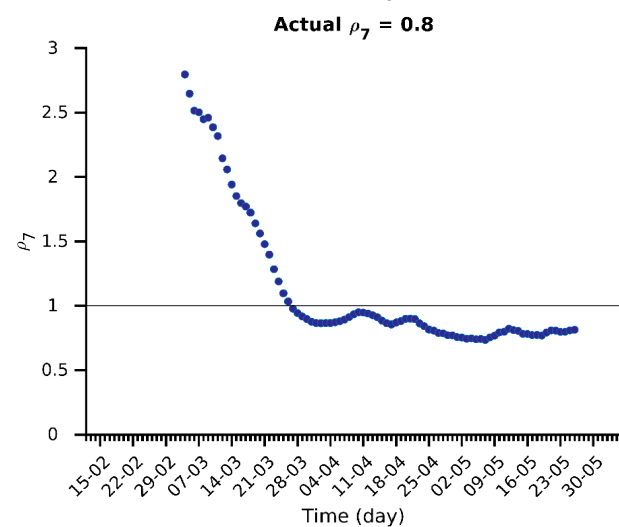
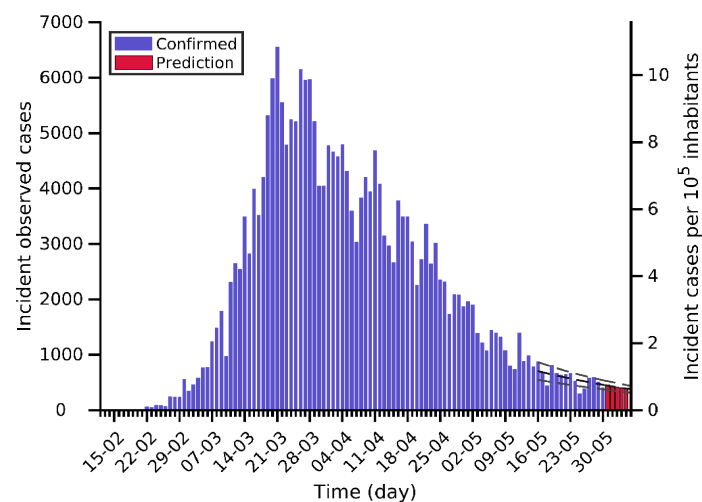
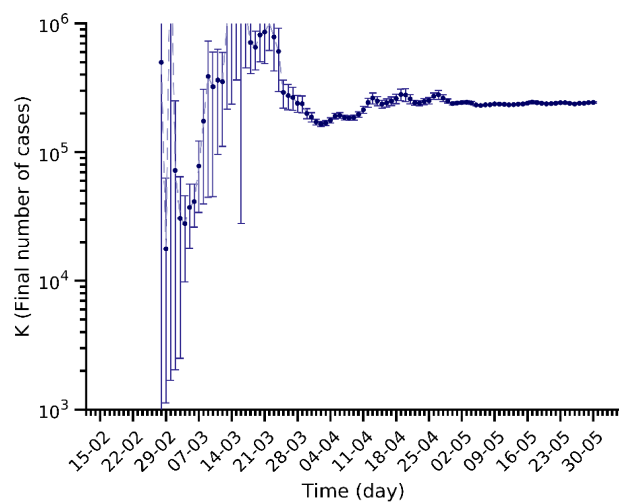
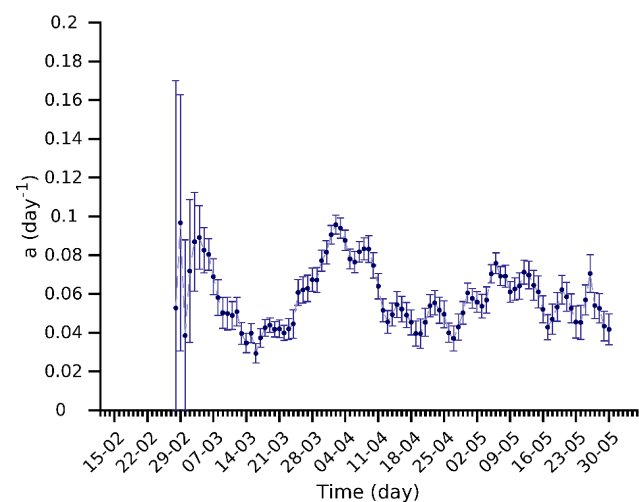
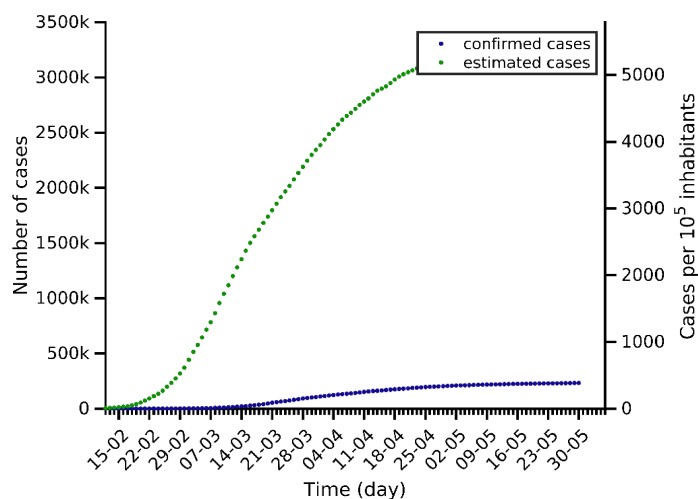
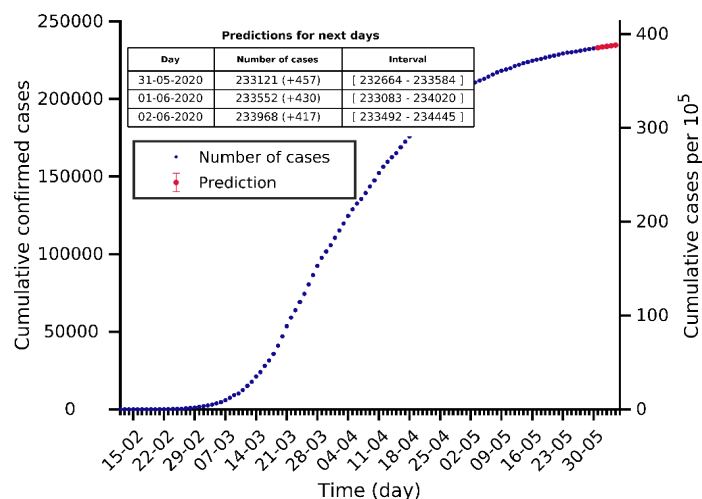
# UK 30-05-2020. Population: 67.9M. Current cumulated incidence: 402/10<sup>5</sup>



# Spain 29-05-2020. Population: 47.0M. Current cumulated incidence: 509/10<sup>5</sup>

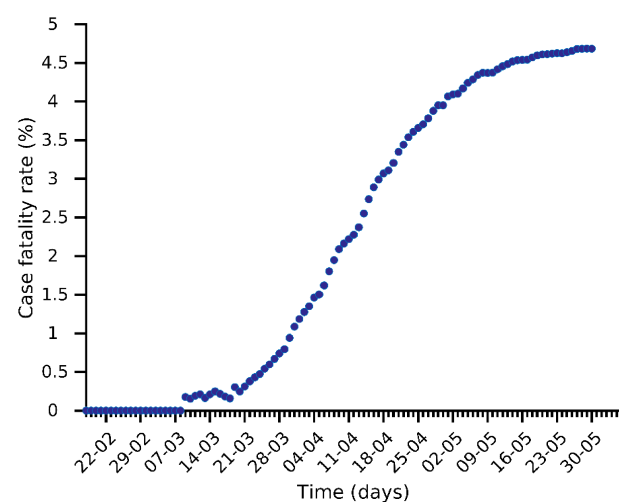
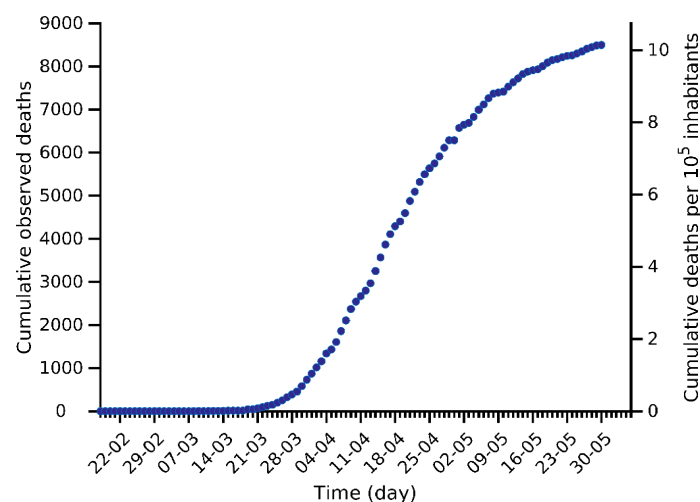
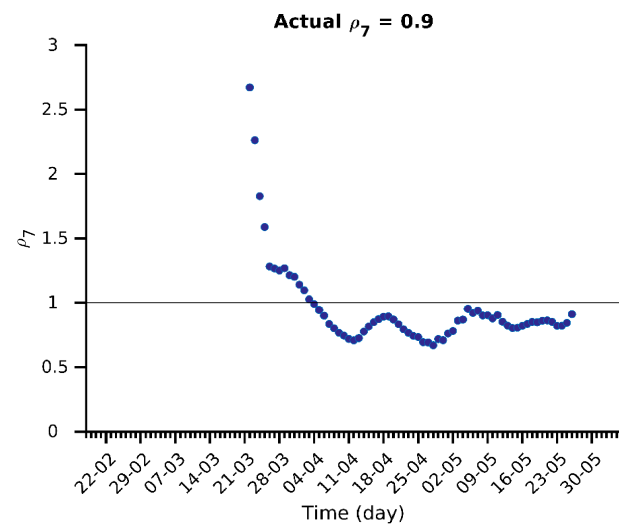
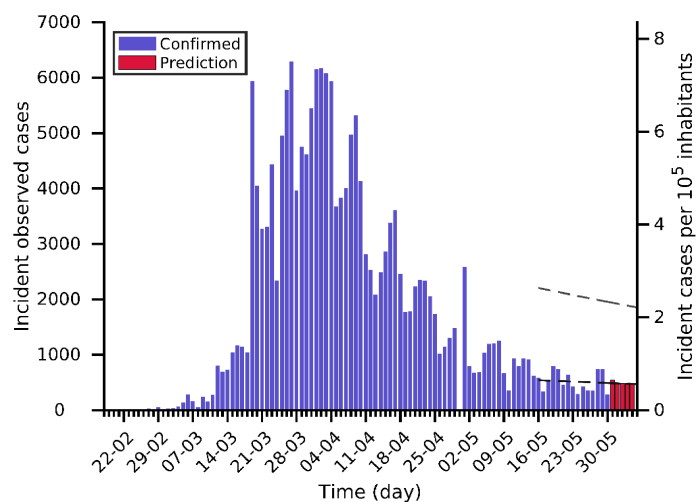
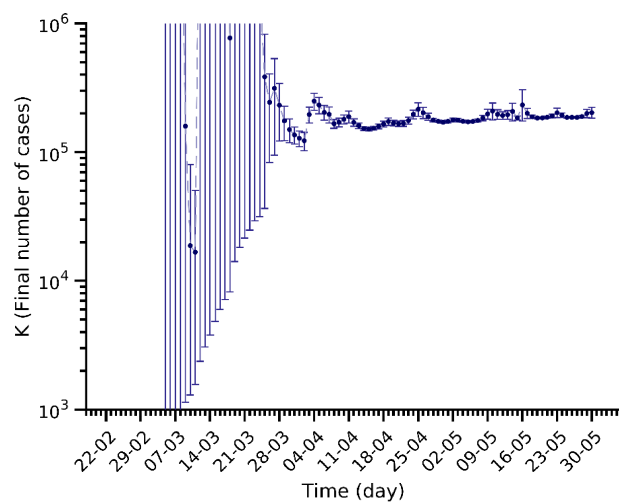
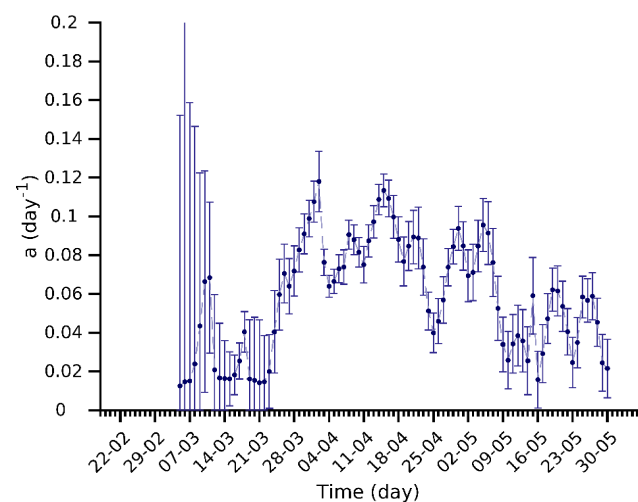
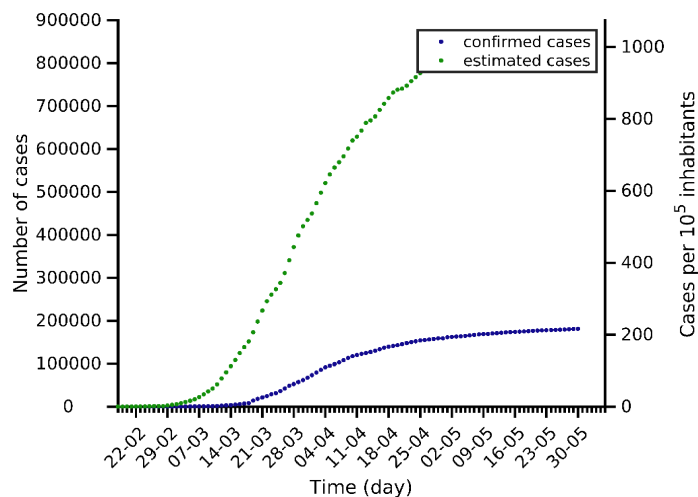
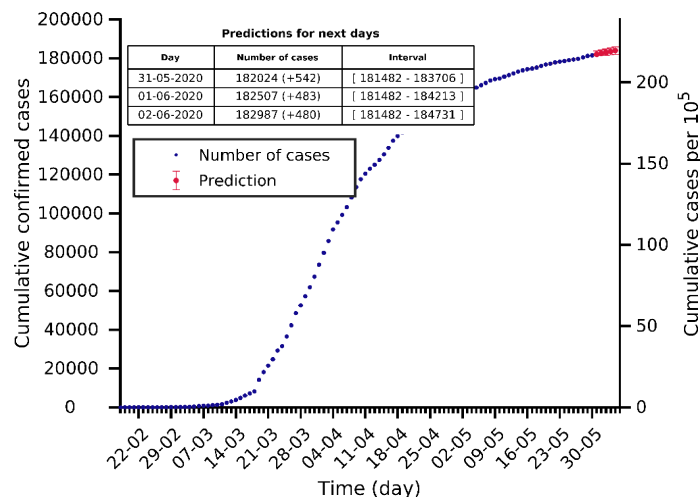


# Italy 30-05-2020. Population: 60.5M. Current cumulated incidence: 385/10<sup>5</sup>

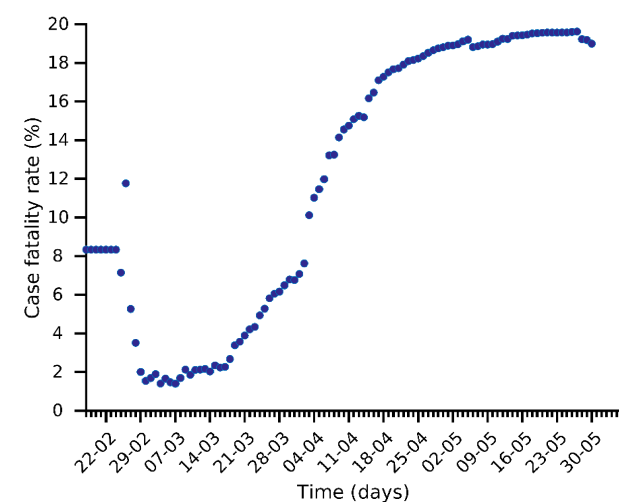
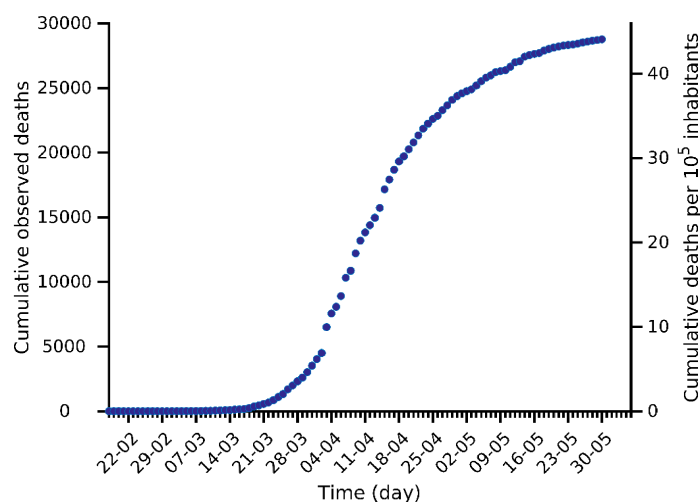
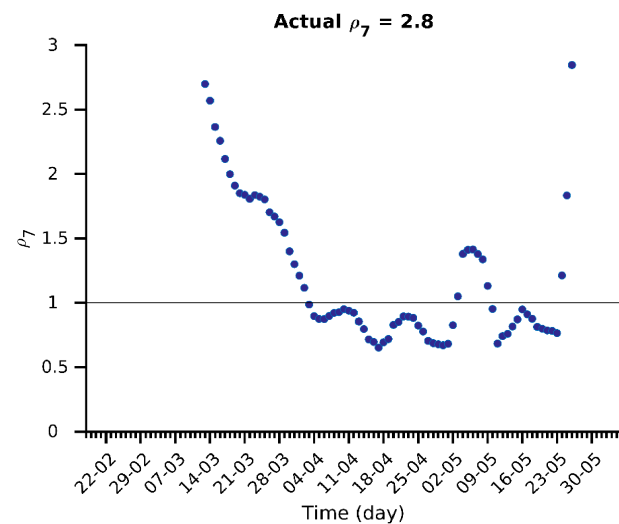
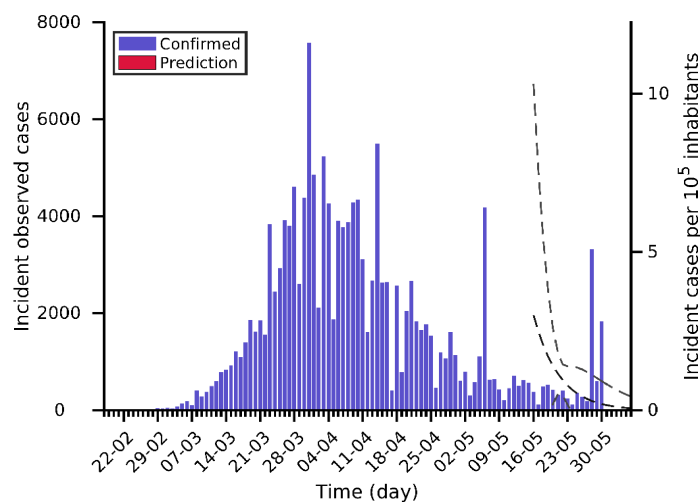
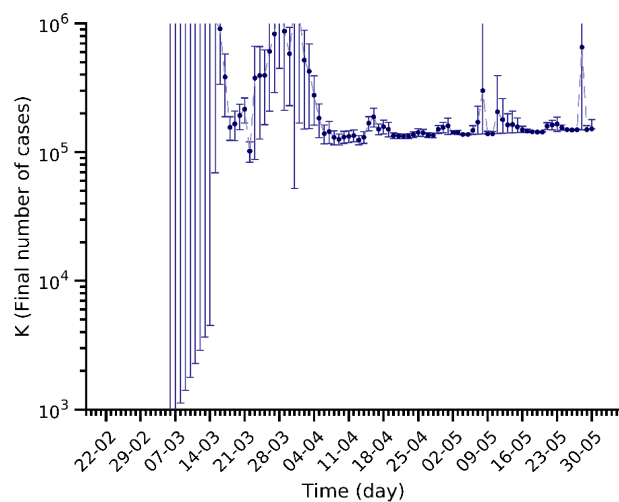
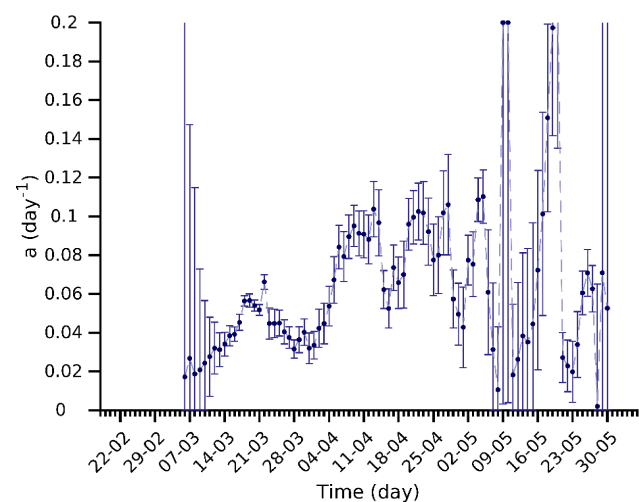
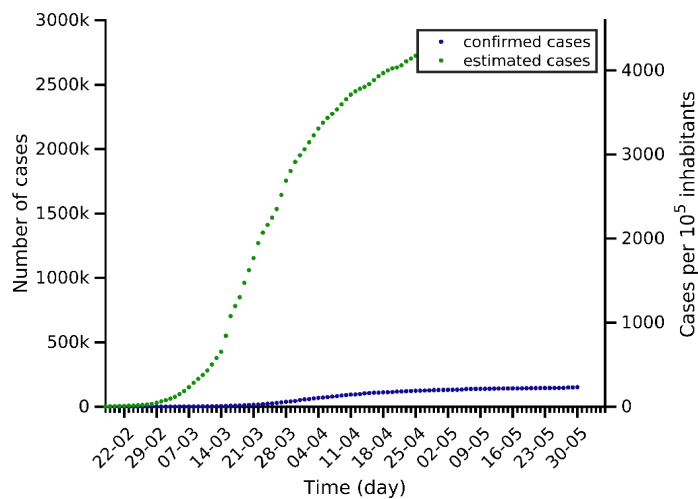
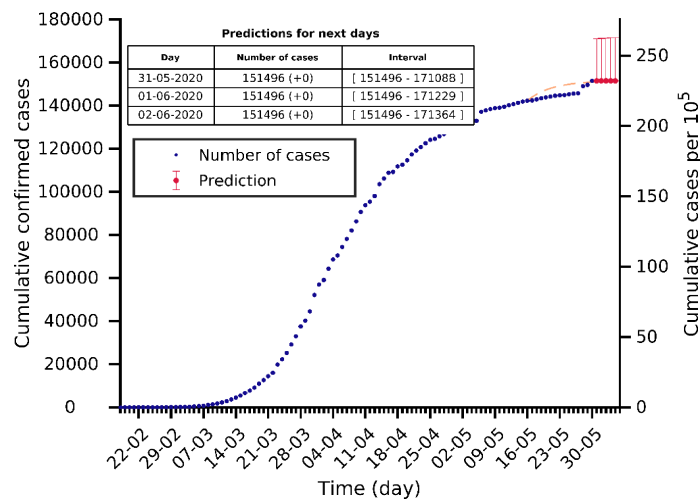




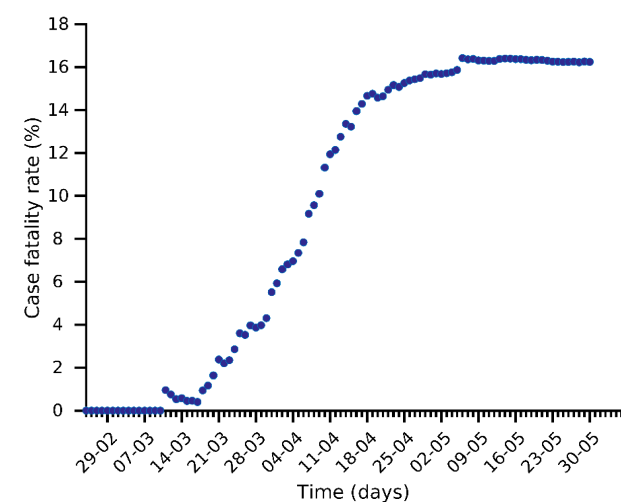
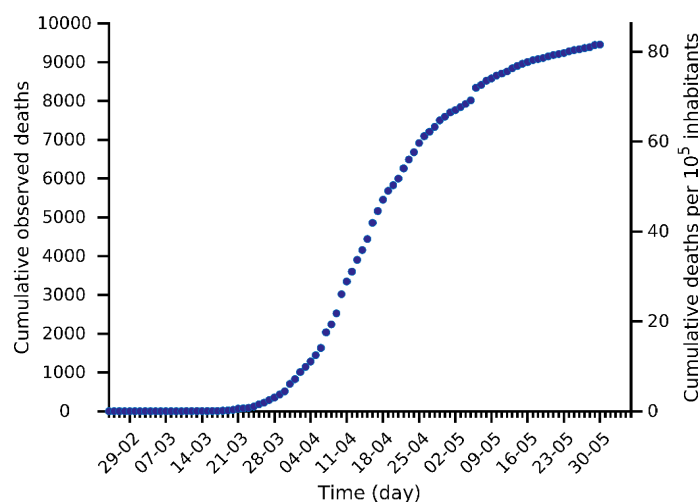
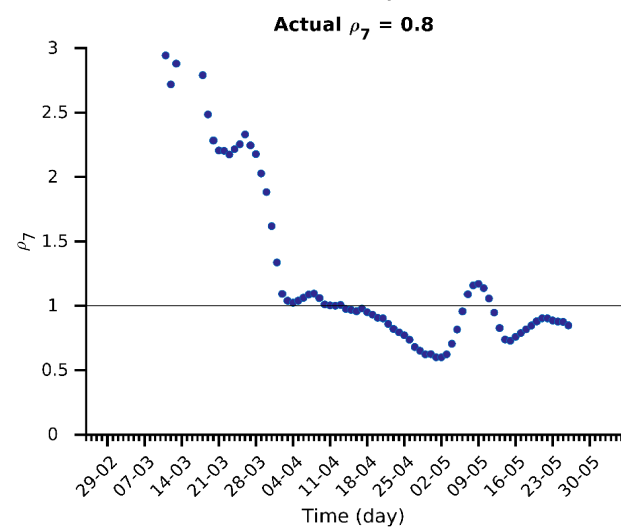
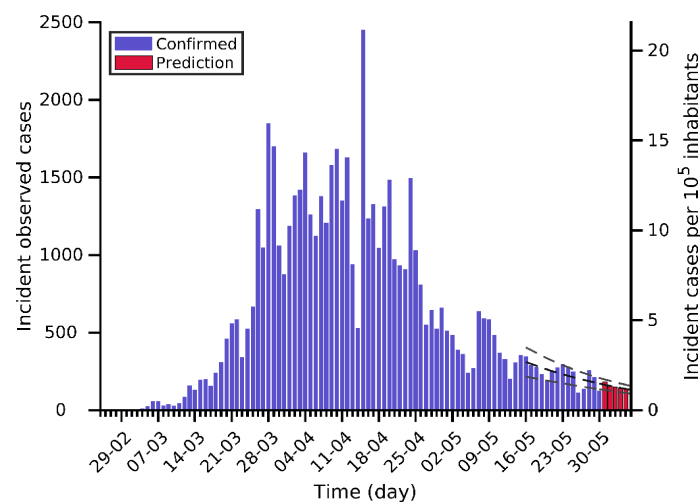
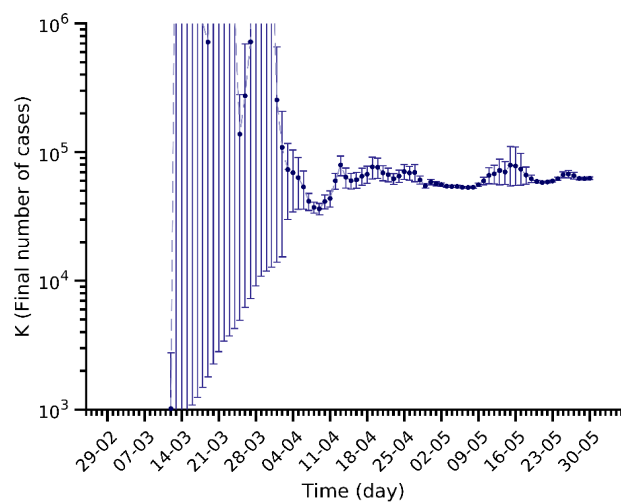
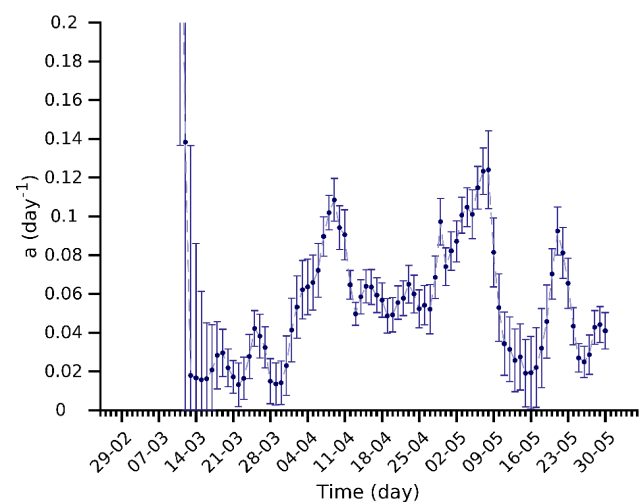
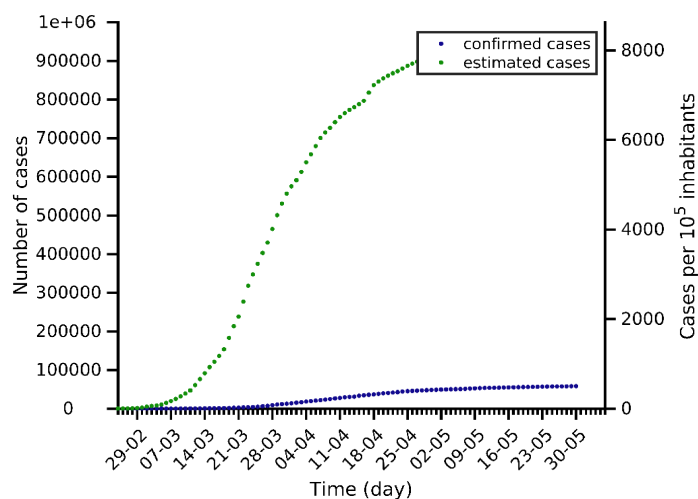
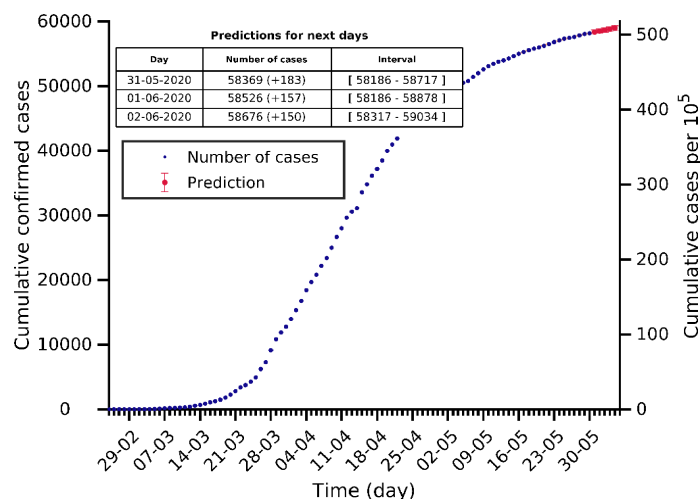
# Germany 30-05-2020. Population: 83.8M. Current cumulated incidence: 217/10<sup>5</sup>



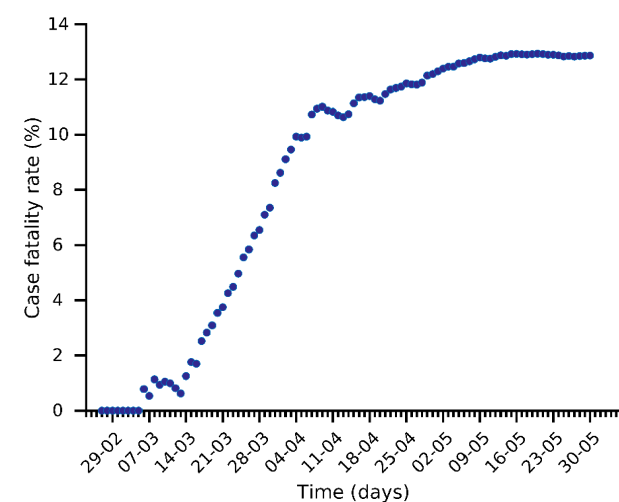
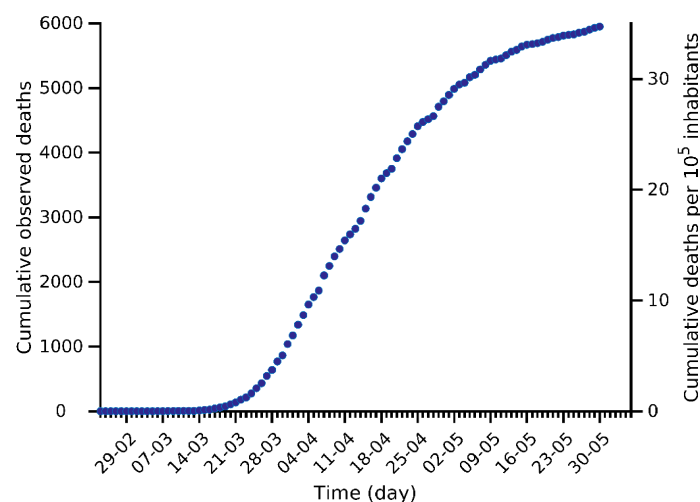
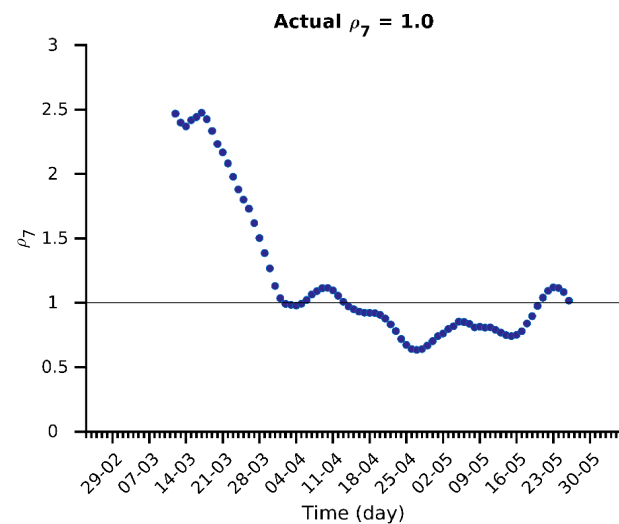
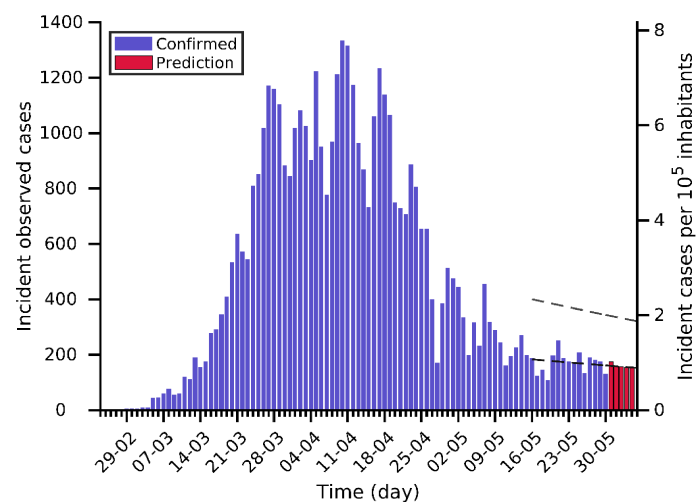
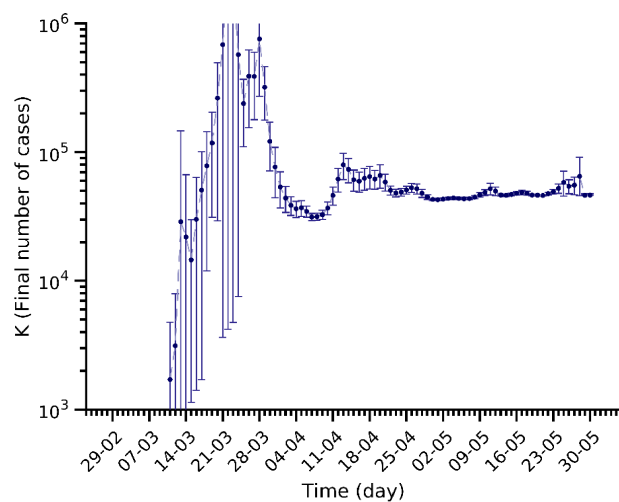
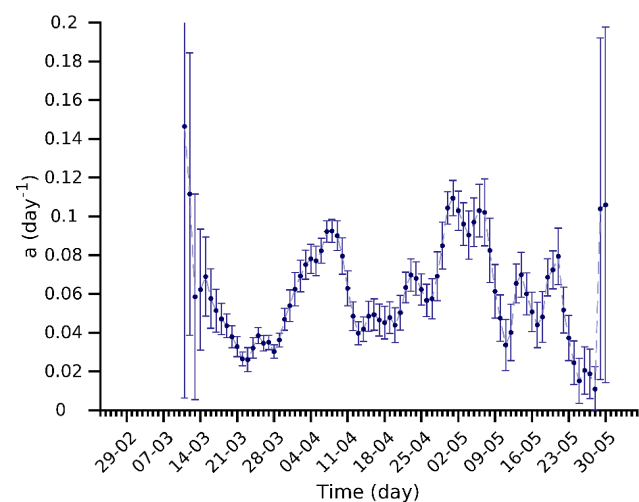
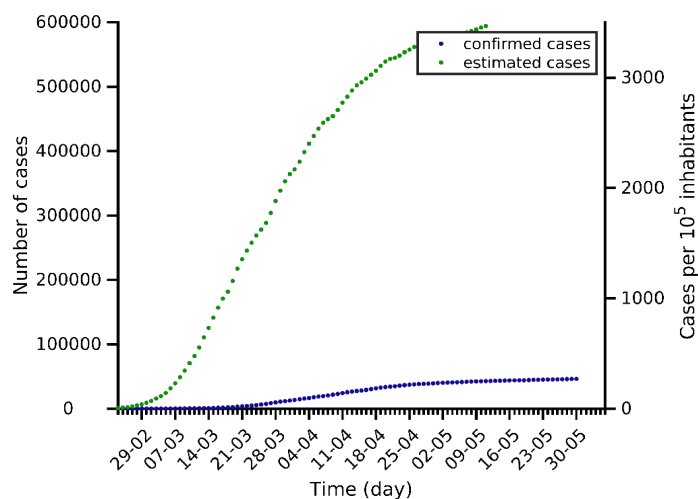
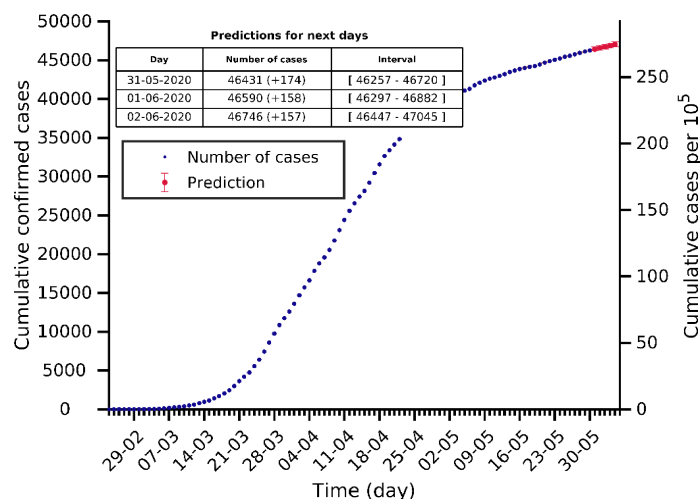
# France 30-05-2020. Population: 65.3M. Current cumulated incidence: 232/10<sup>5</sup>



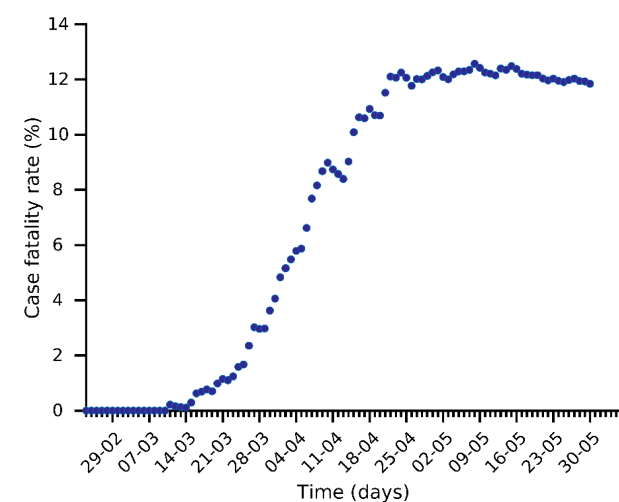
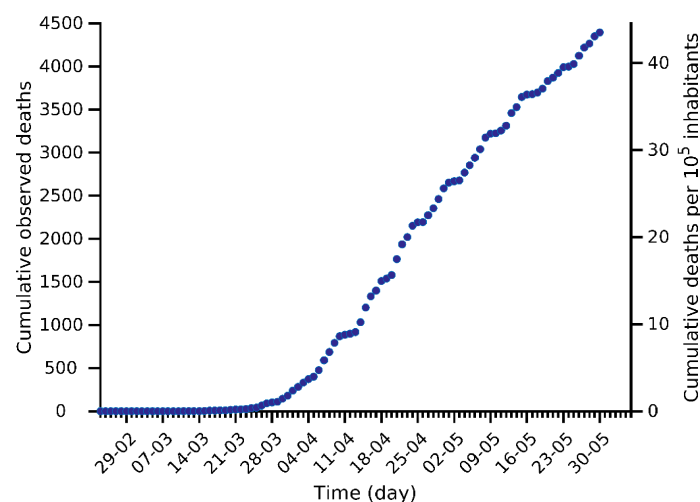
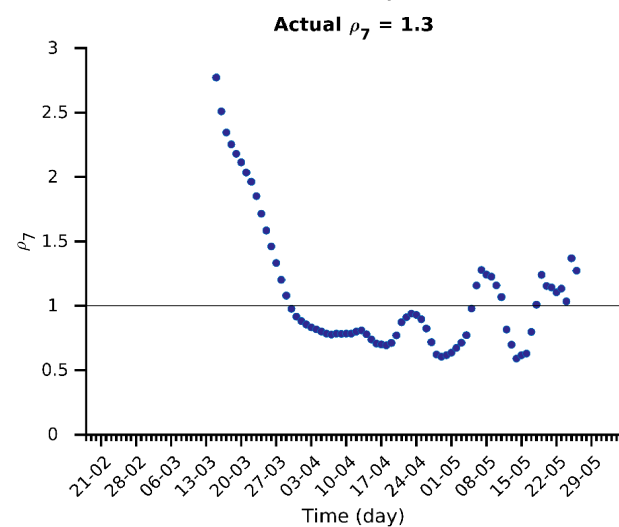
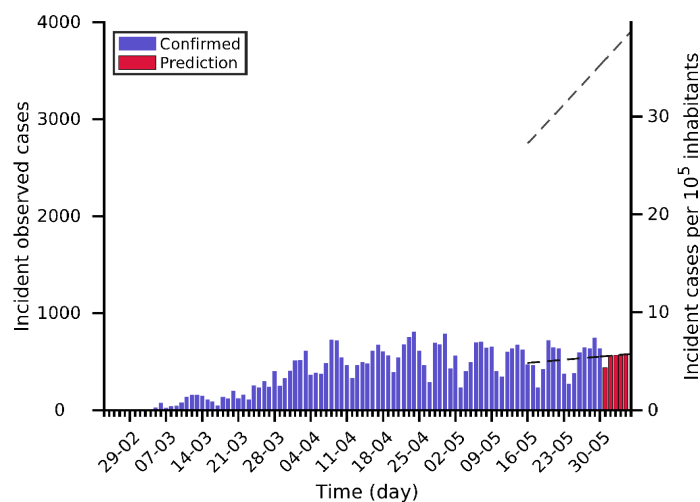
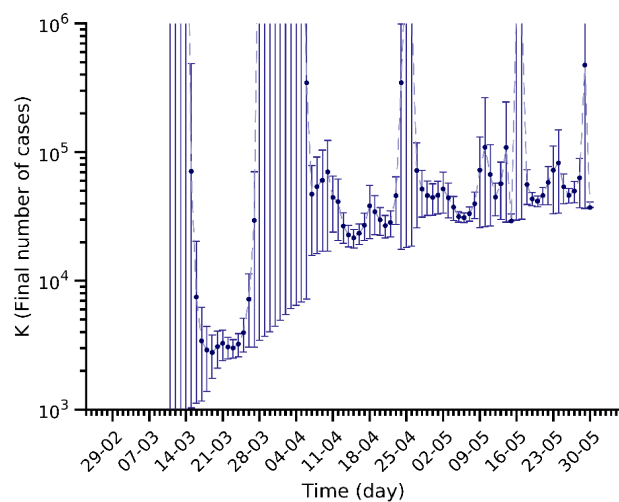
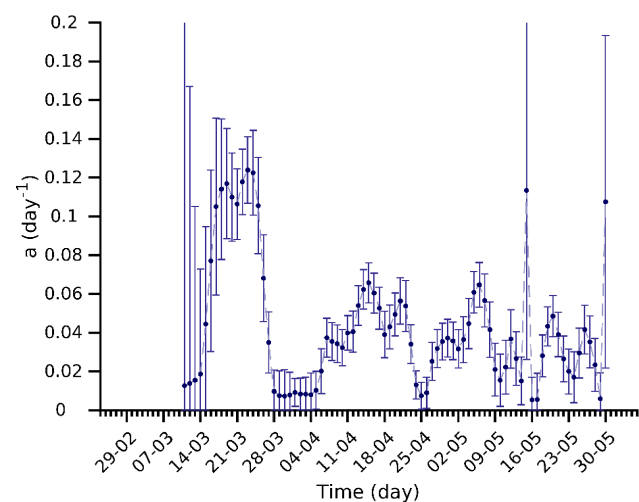
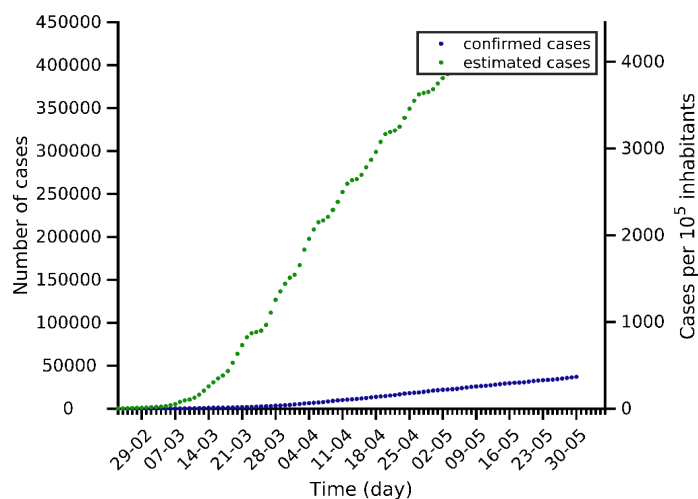
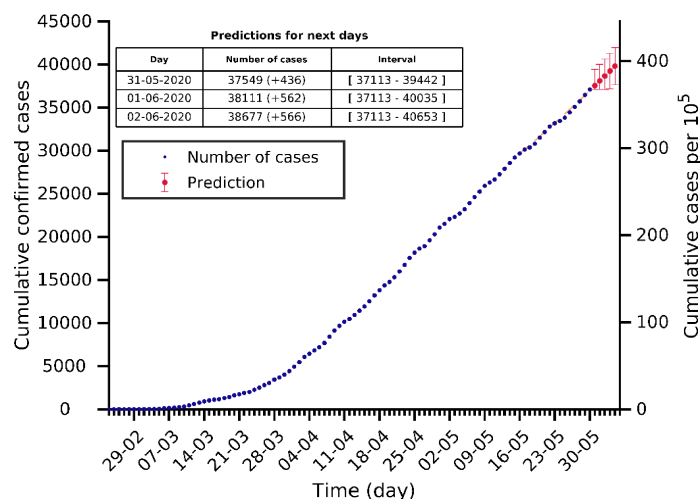
# Belgium 30-05-2020. Population: 11.6M. Current cumulated incidence: 502/10<sup>5</sup>



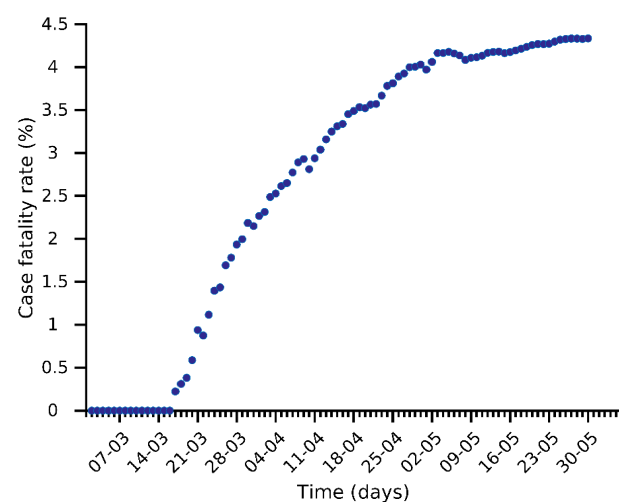
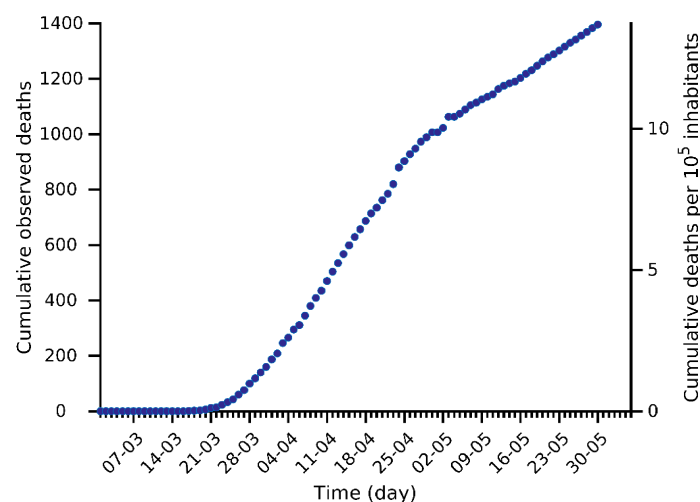
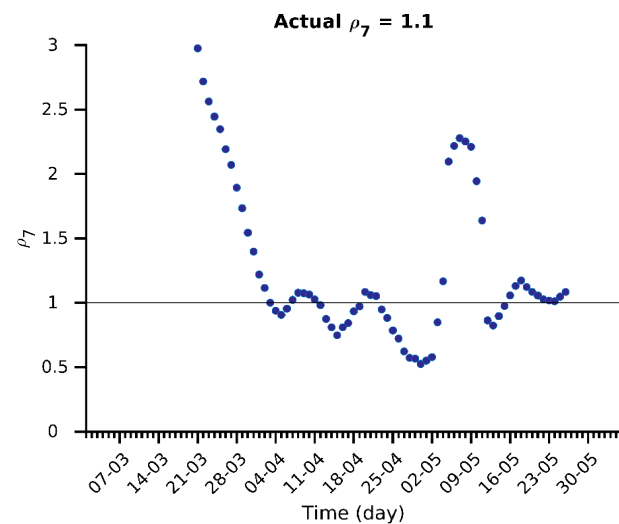
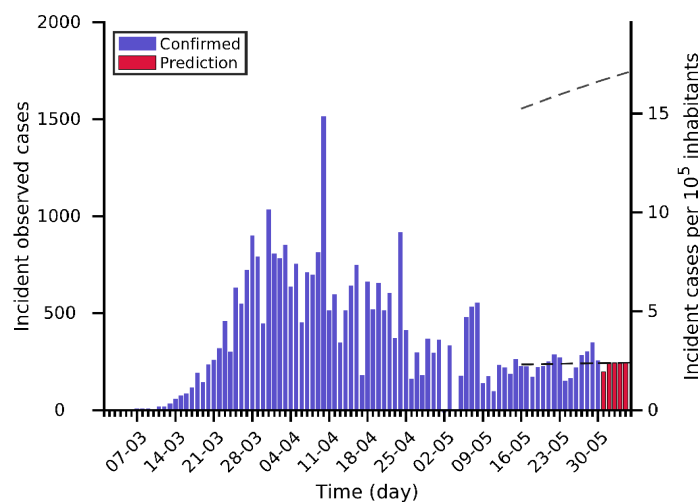
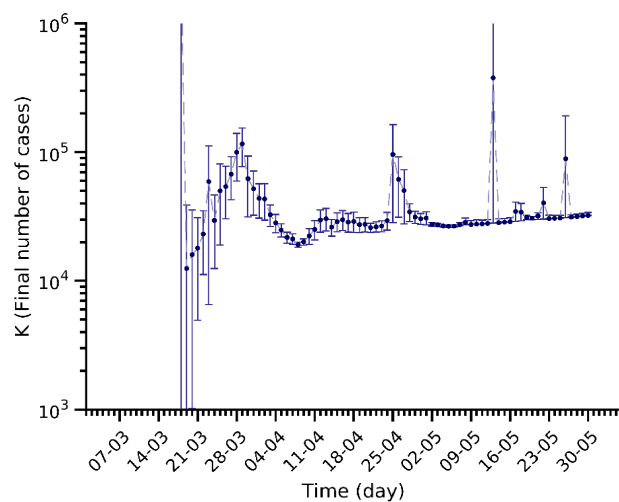
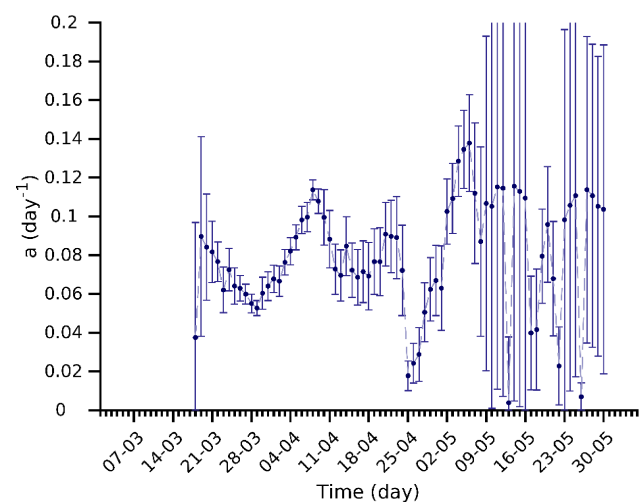
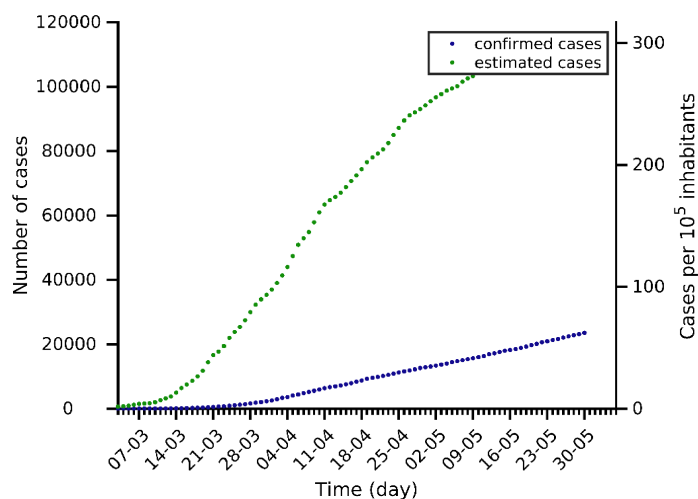
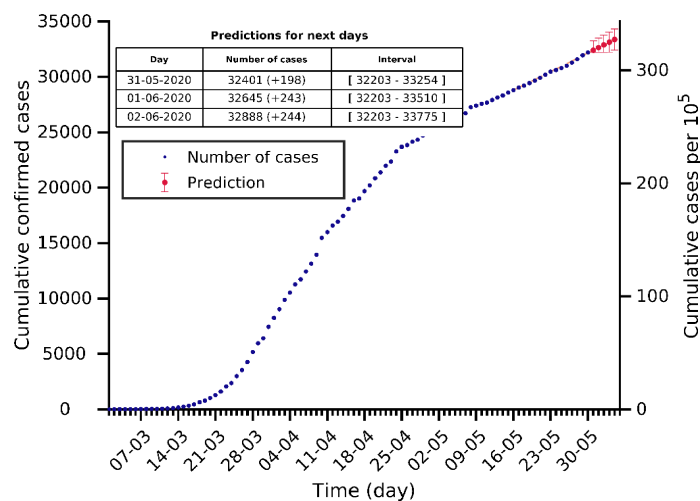
# Netherlands 30-05-2020. Population: 17.1M. Current cumulated incidence: 270/10<sup>5</sup>



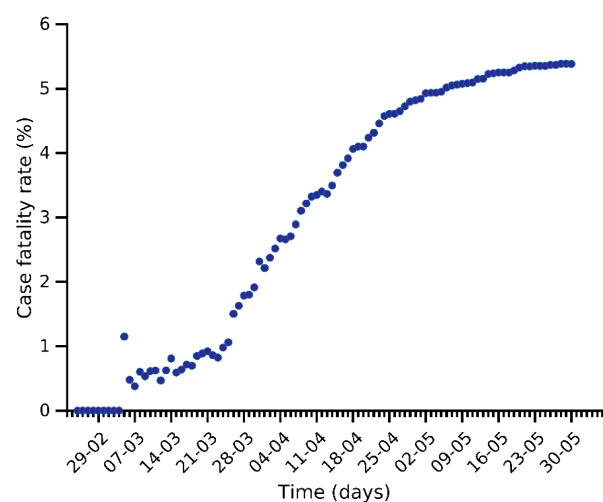
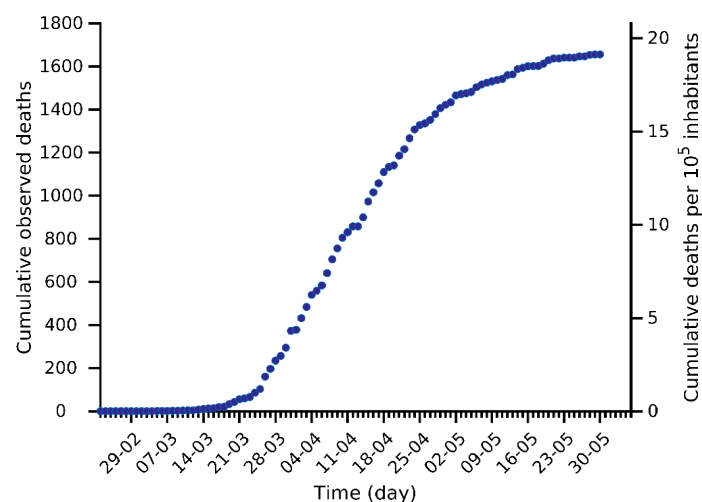
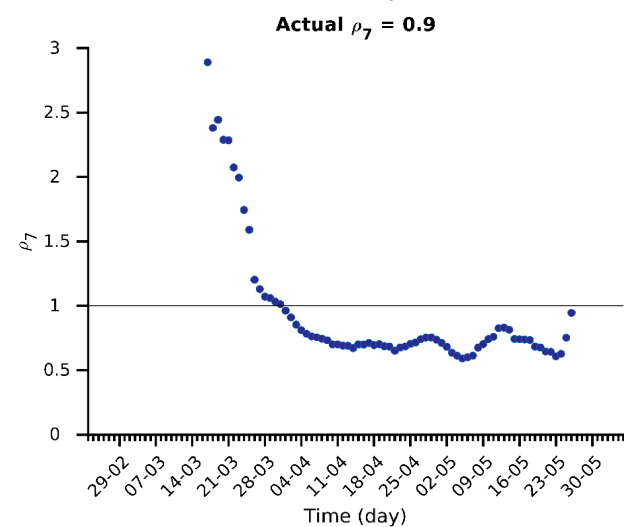
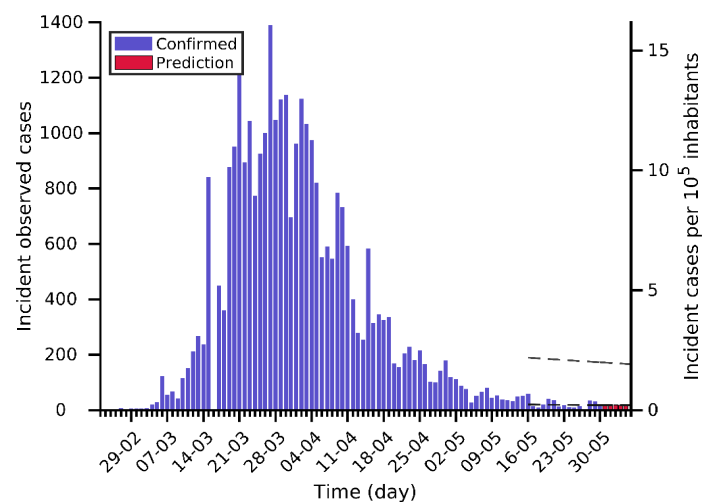
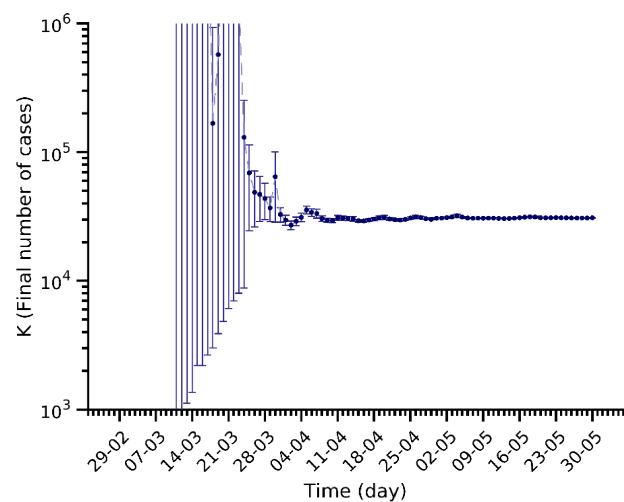
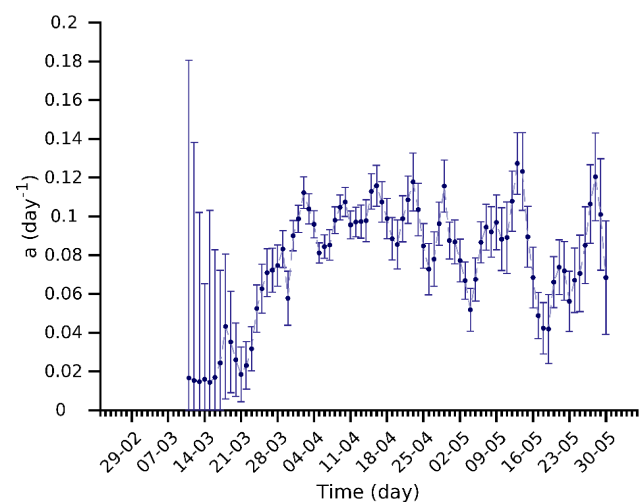
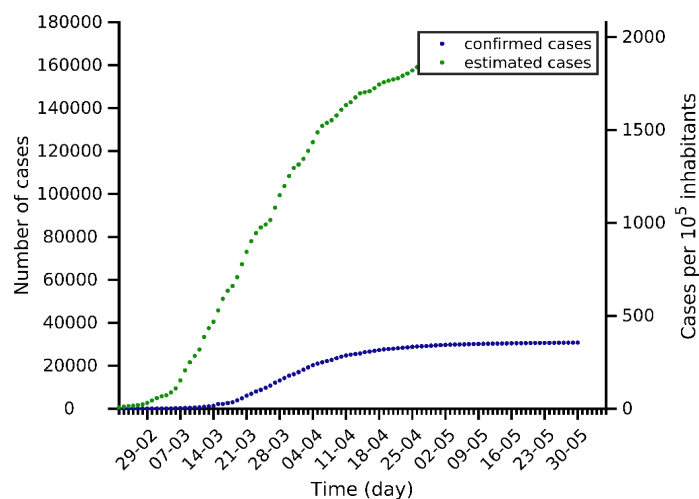
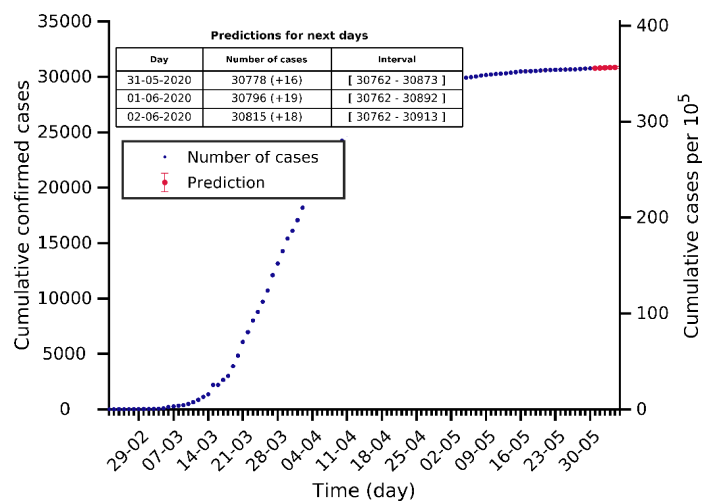
# Sweden 30-05-2020. Population: 10.1M. Current cumulated incidence: 367/10<sup>5</sup>



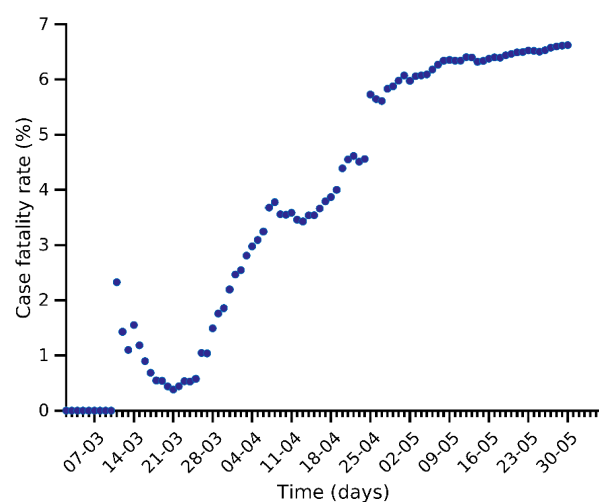
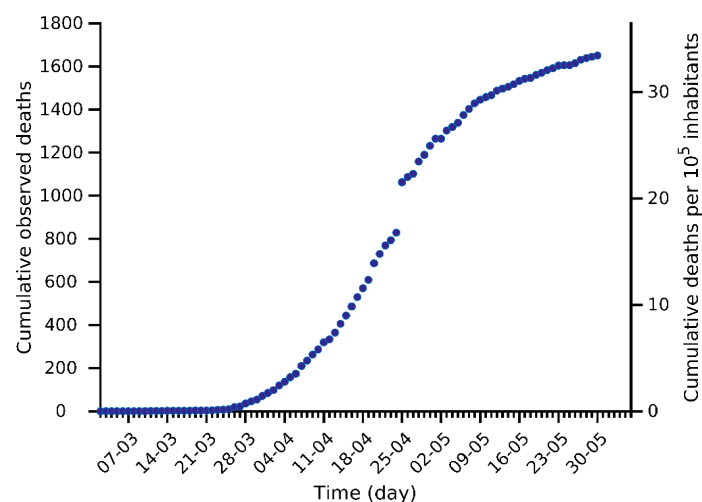
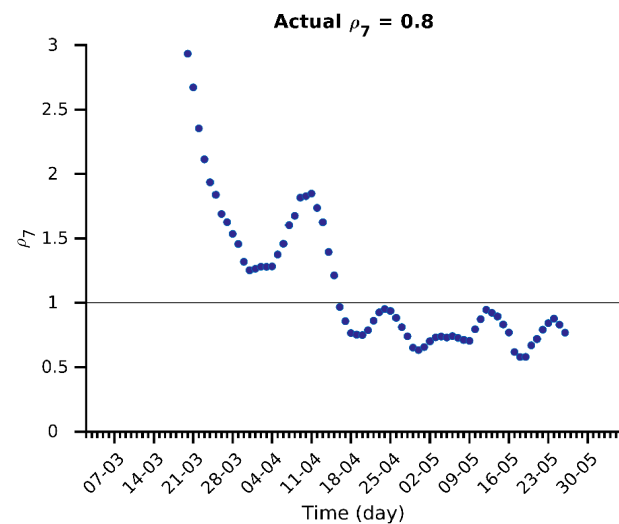
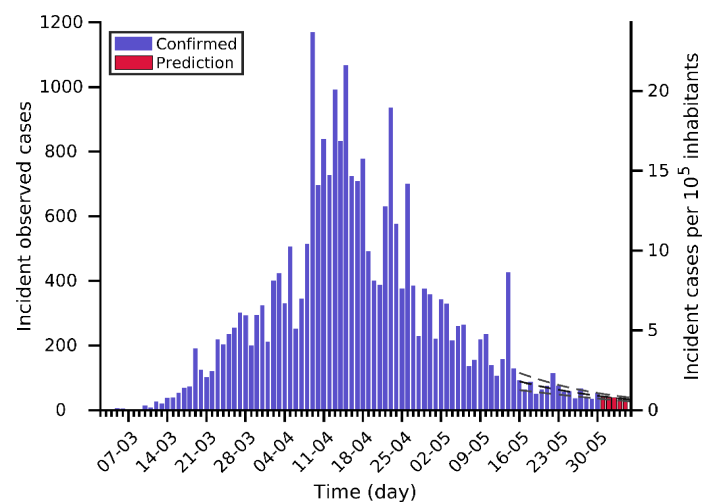
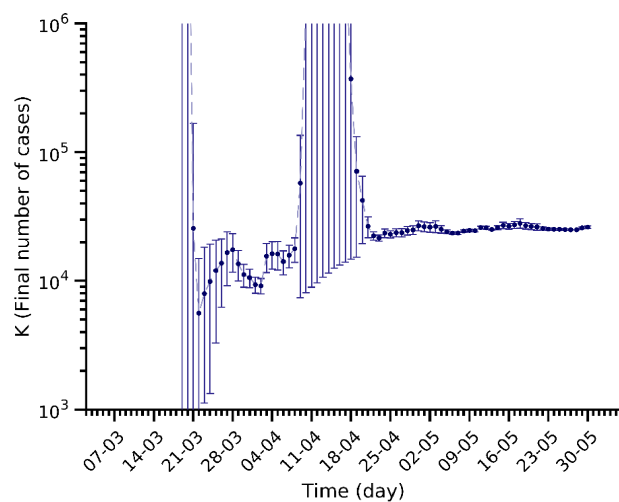
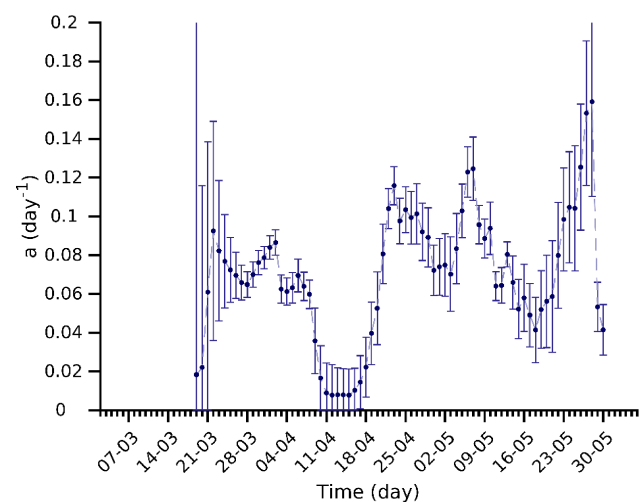
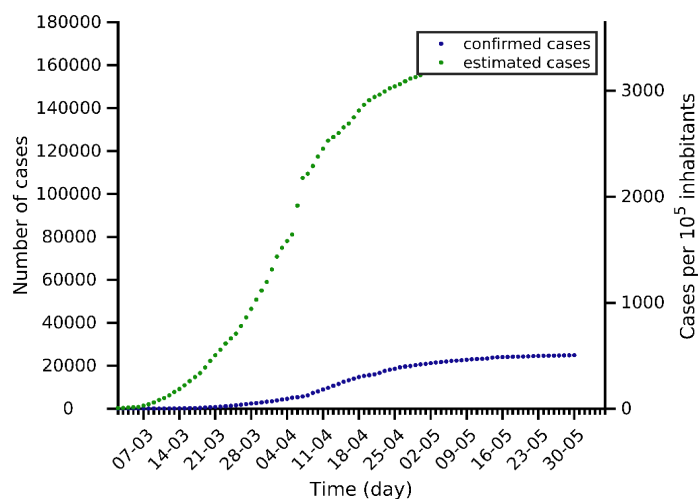
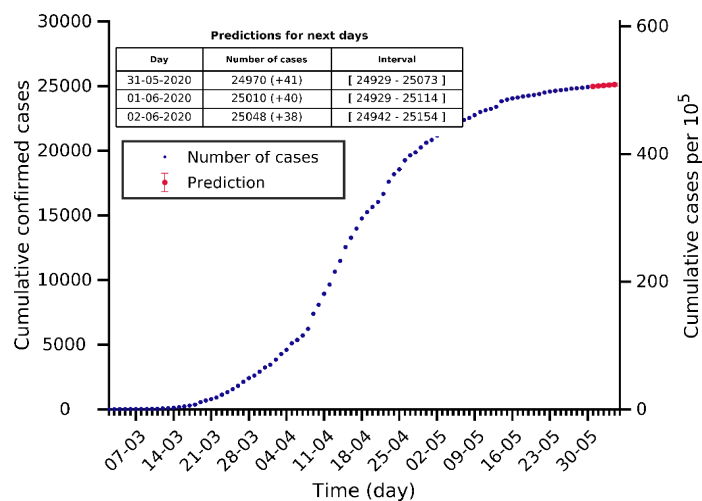
# Portugal 30-05-2020. Population: 10.2M. Current cumulated incidence: 316/10<sup>5</sup>



# Switzerland 30-05-2020. Population: 8.7M. Current cumulated incidence: 355/10<sup>5</sup>

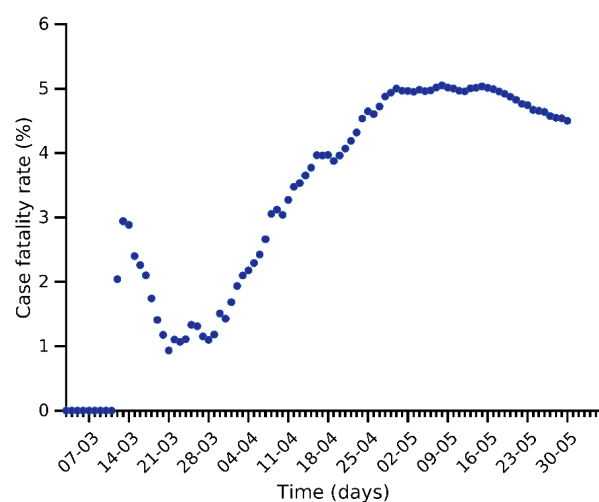
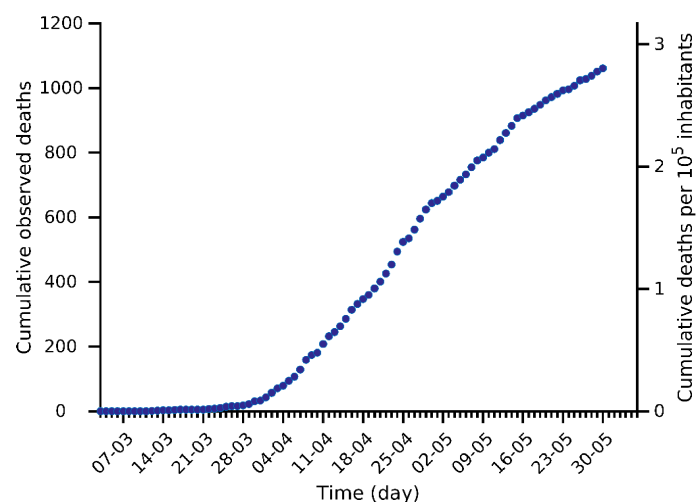
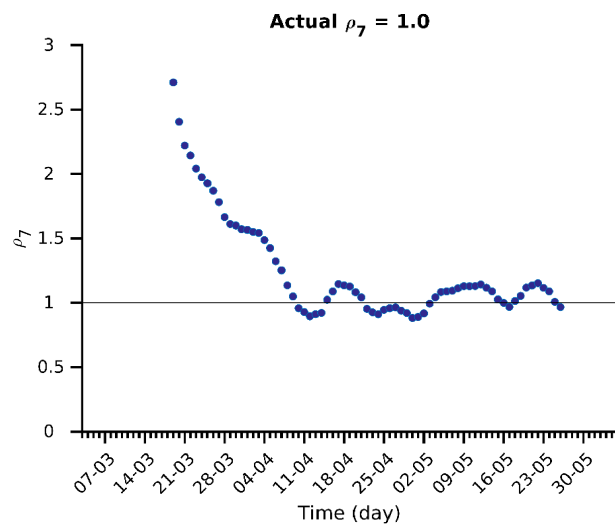
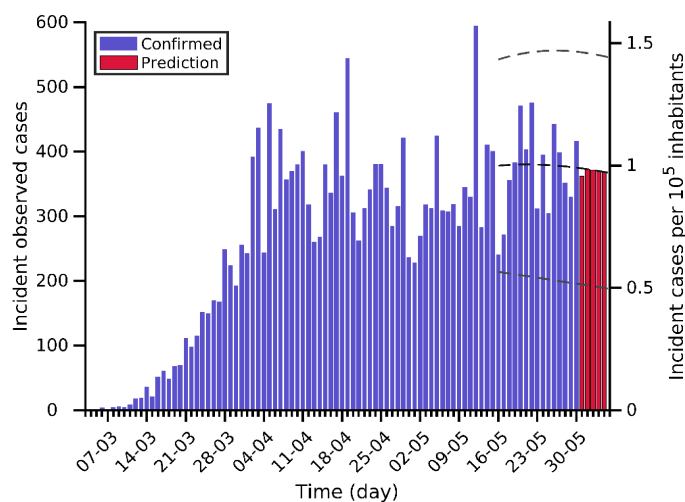
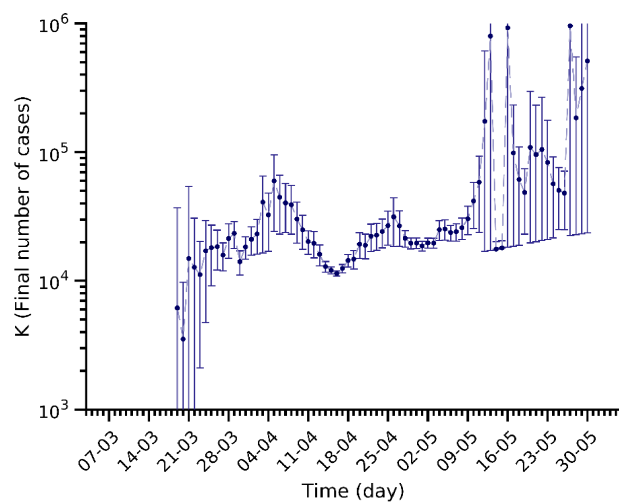
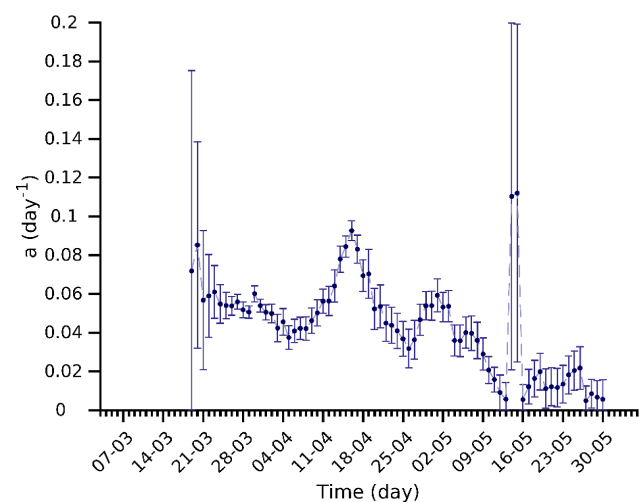
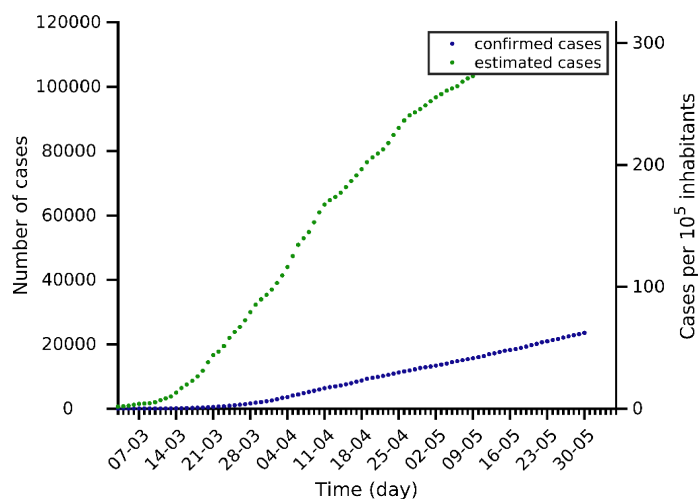
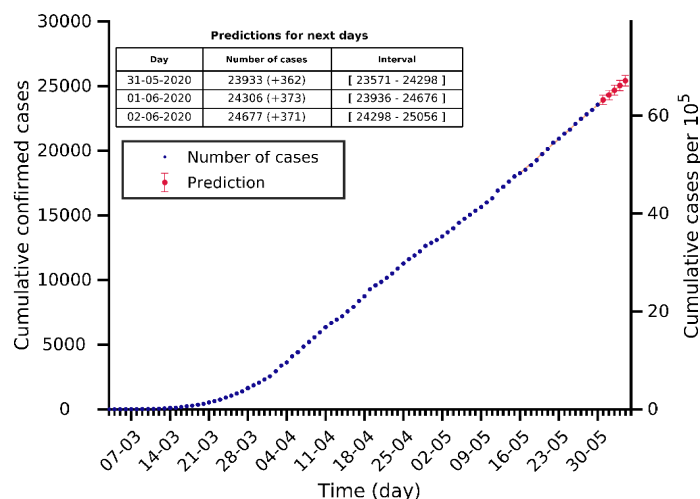


# Ireland 30-05-2020. Population: 4.9M. Current cumulated incidence: 505/10<sup>5</sup>

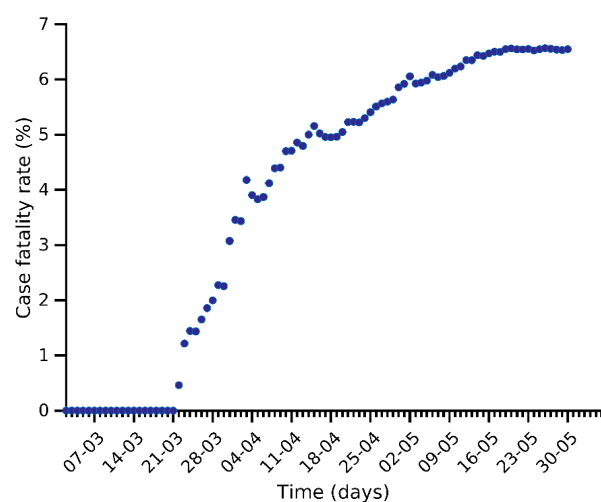
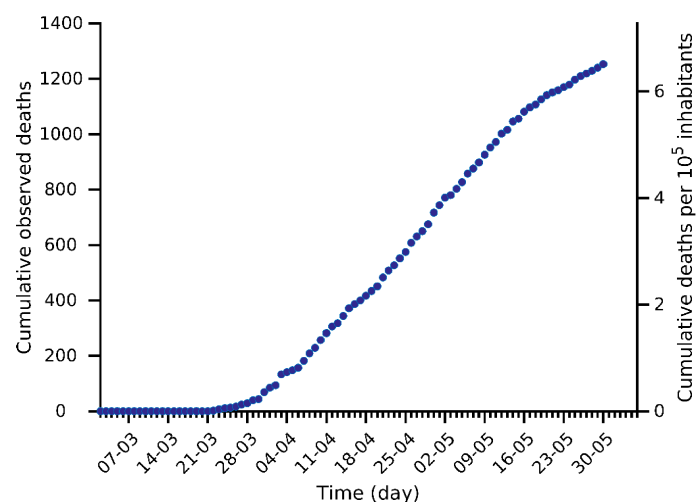
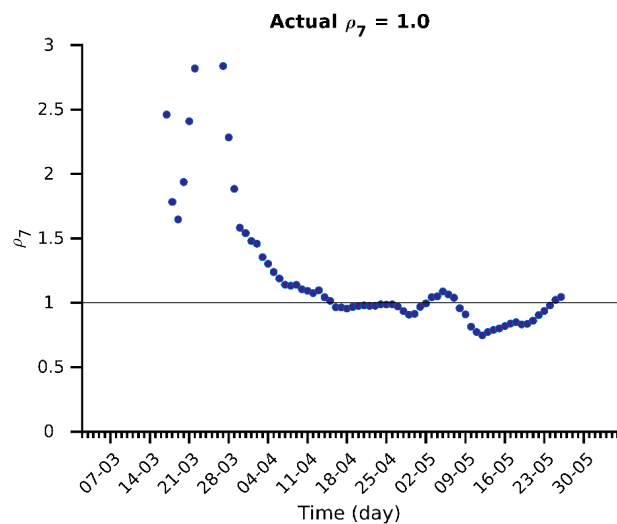
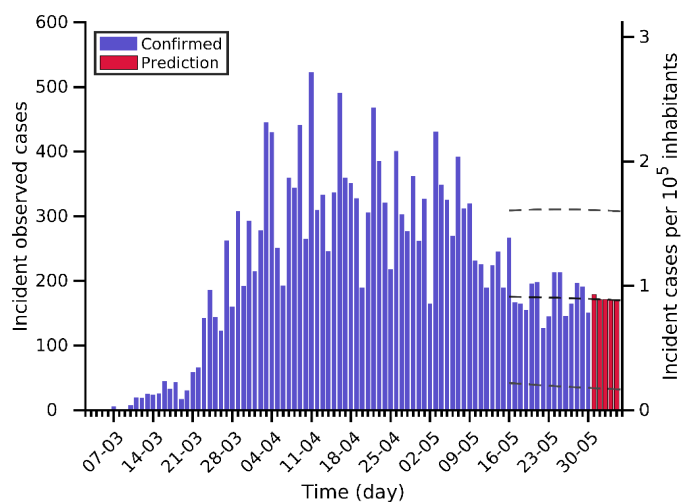
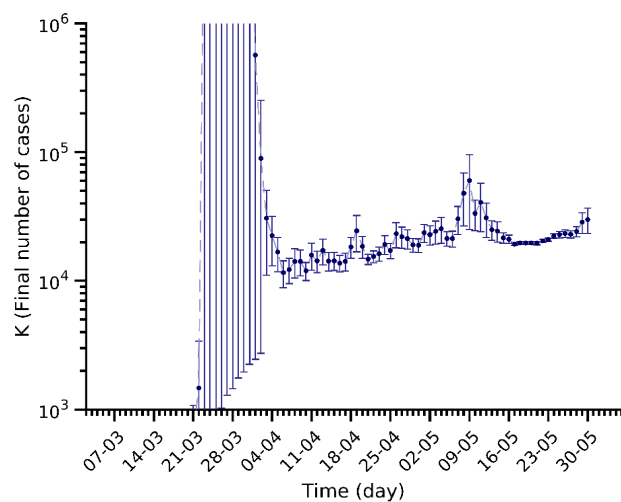
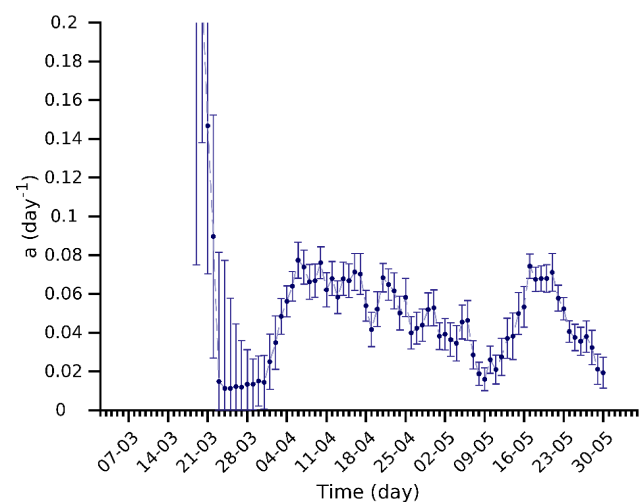
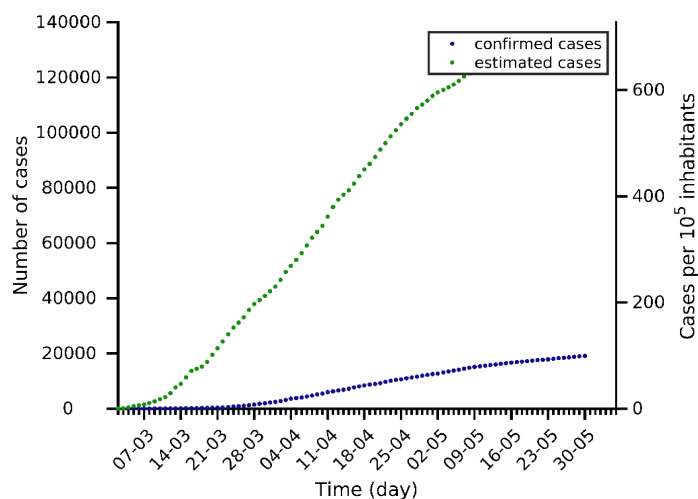
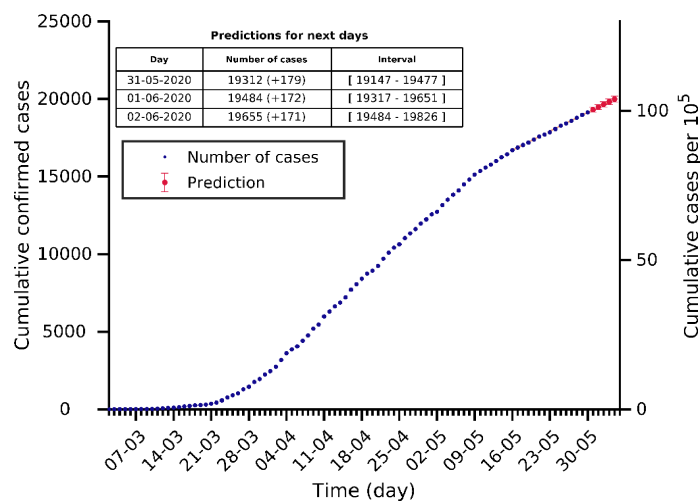




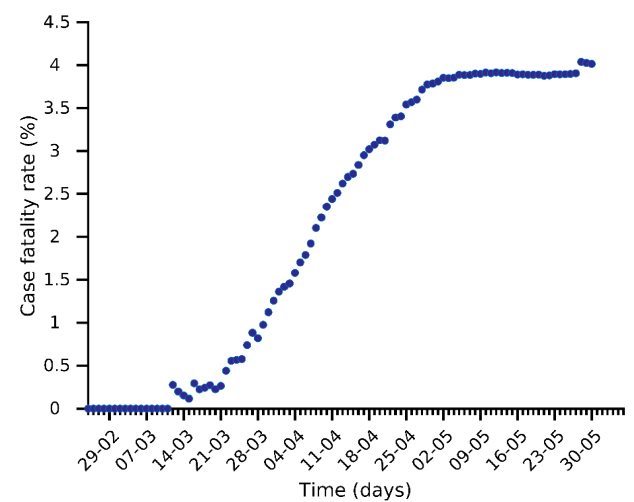
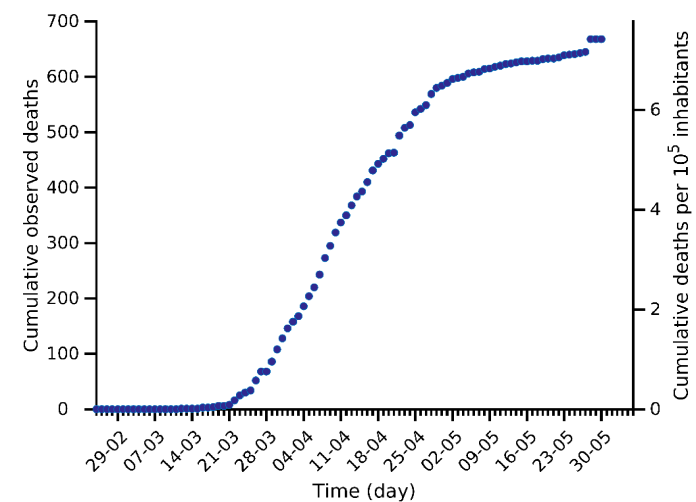
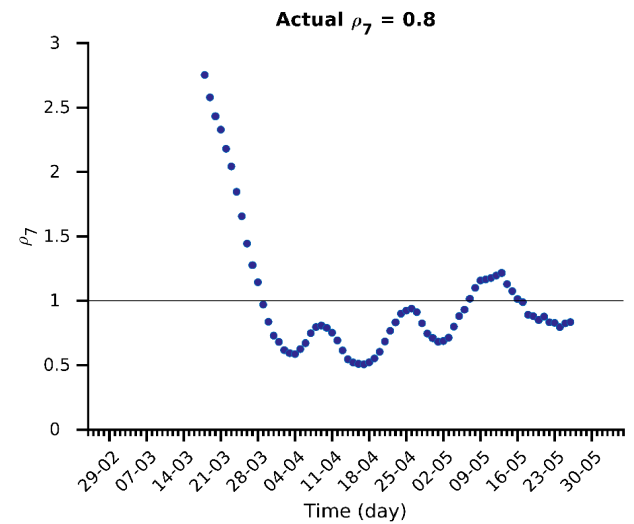
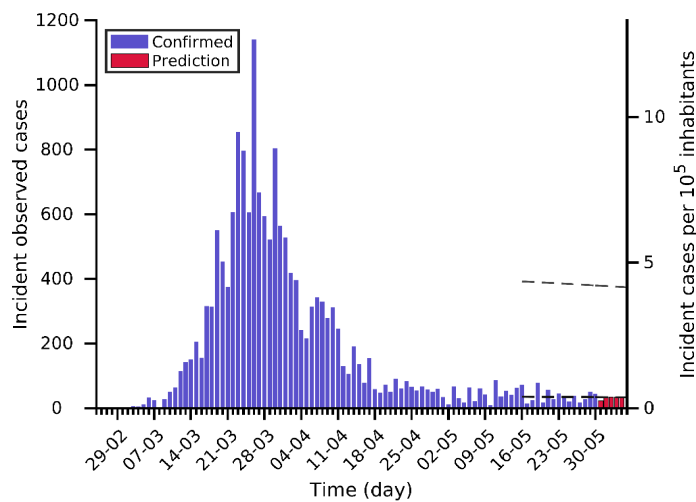
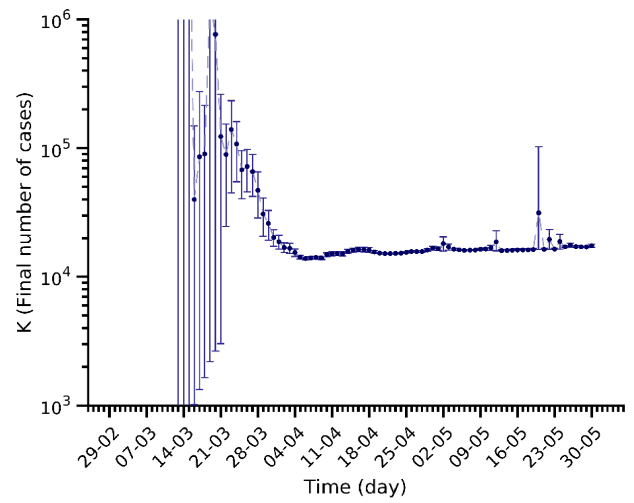
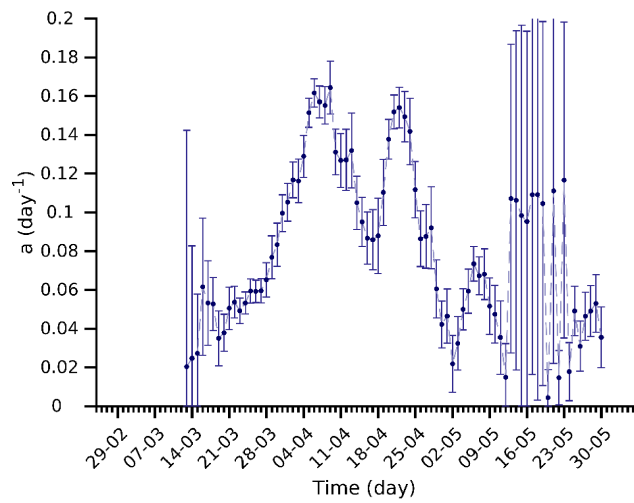
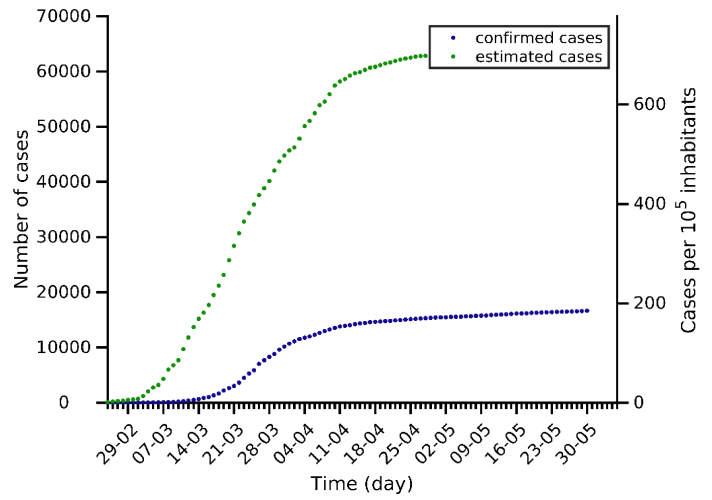
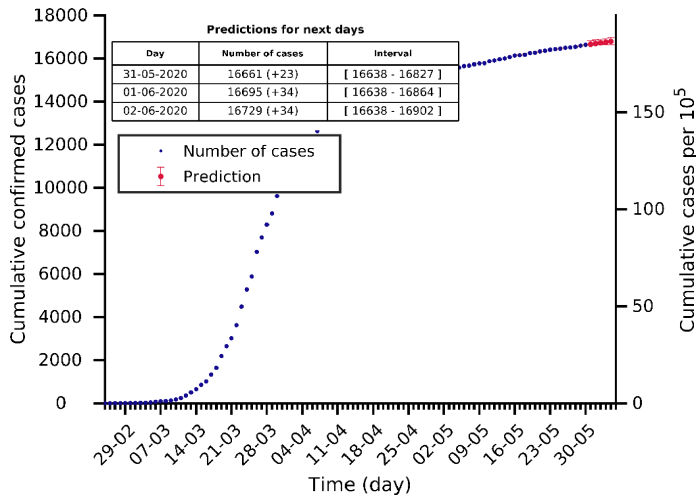
# Poland 30-05-2020. Population: 37.8M. Current cumulated incidence: 62/10<sup>5</sup>



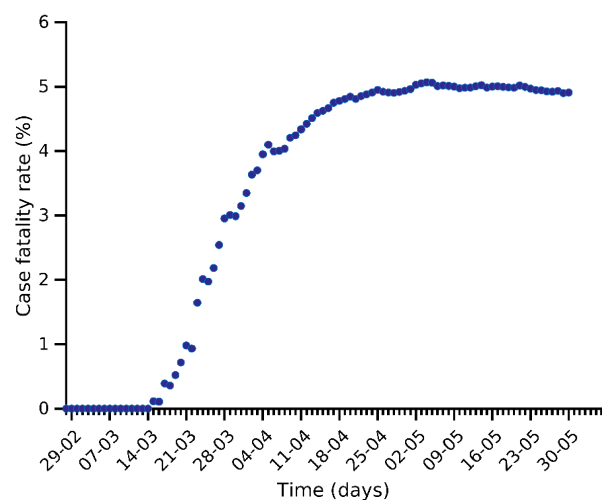
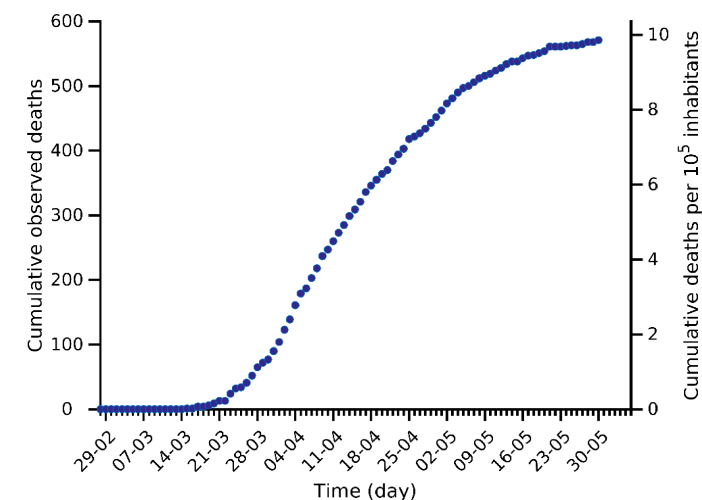
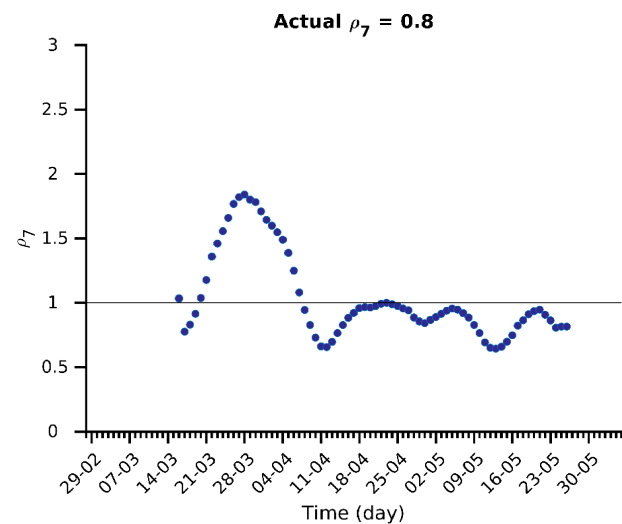
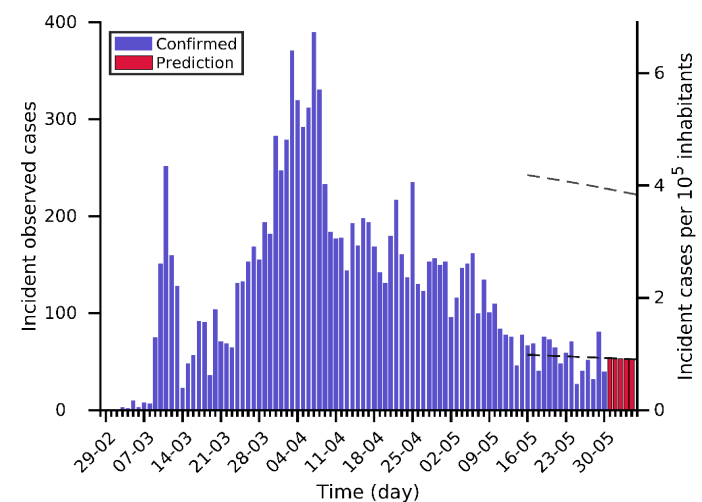
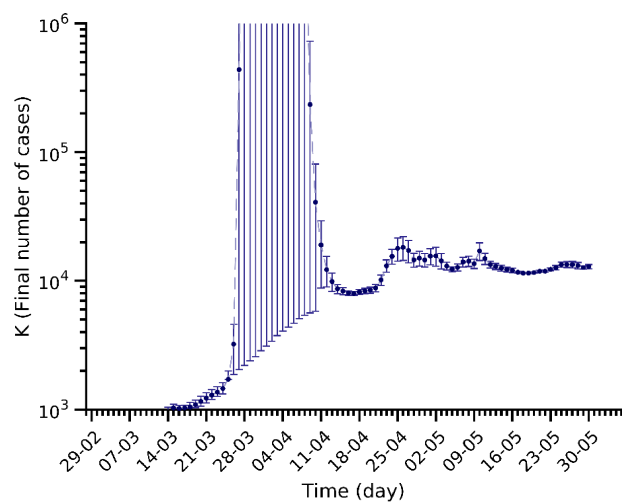
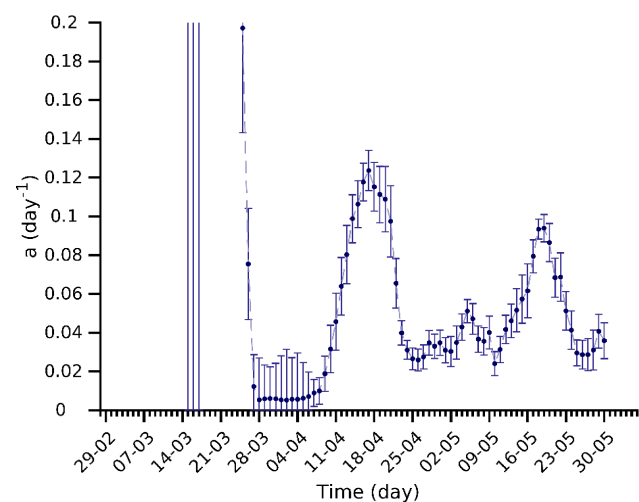
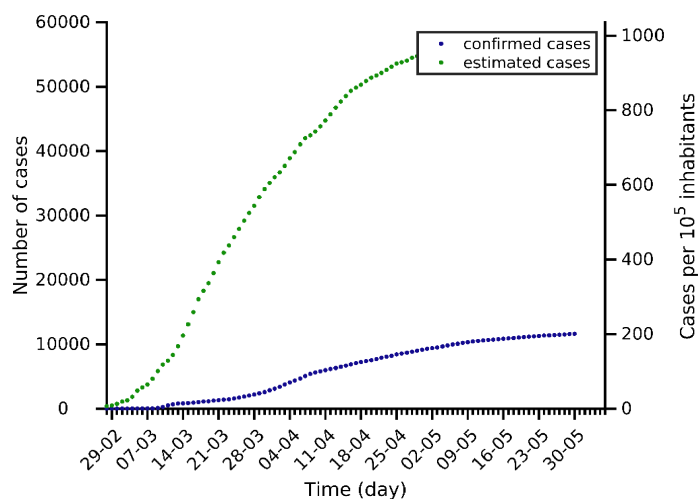
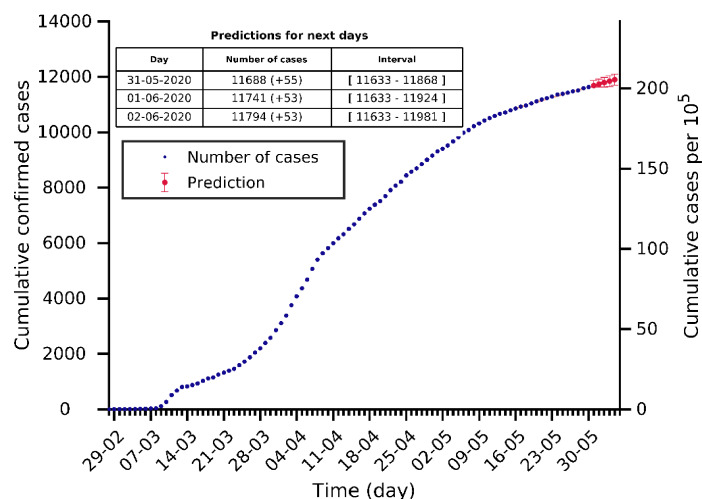
# Romania 30-05-2020. Population: 19.2M. Current cumulated incidence: 99/10<sup>5</sup>



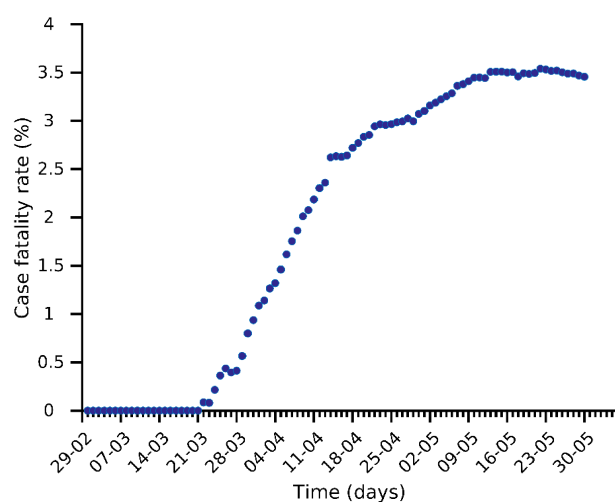
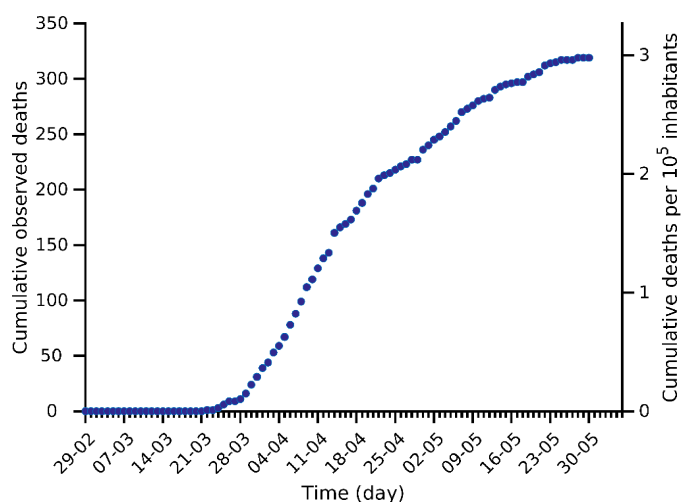
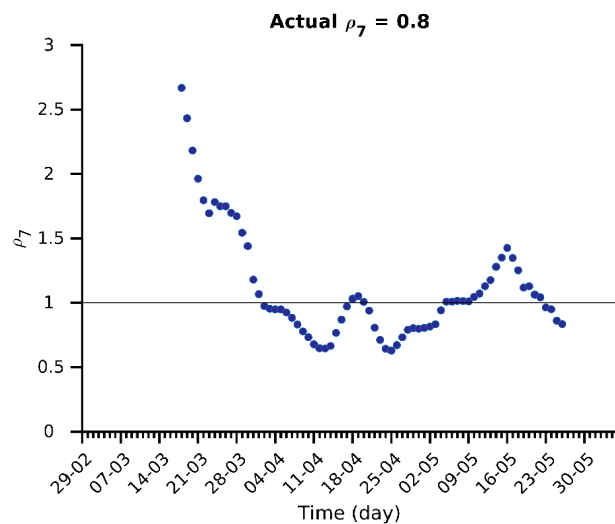
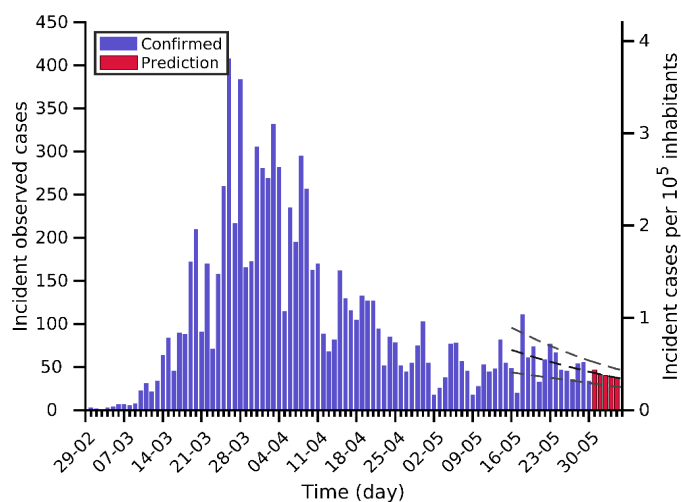
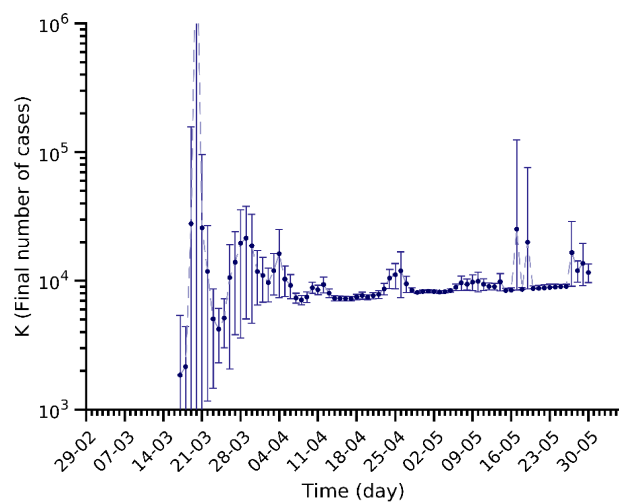
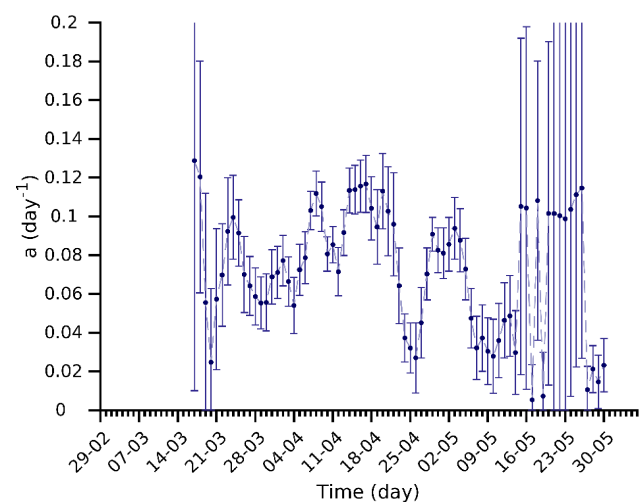
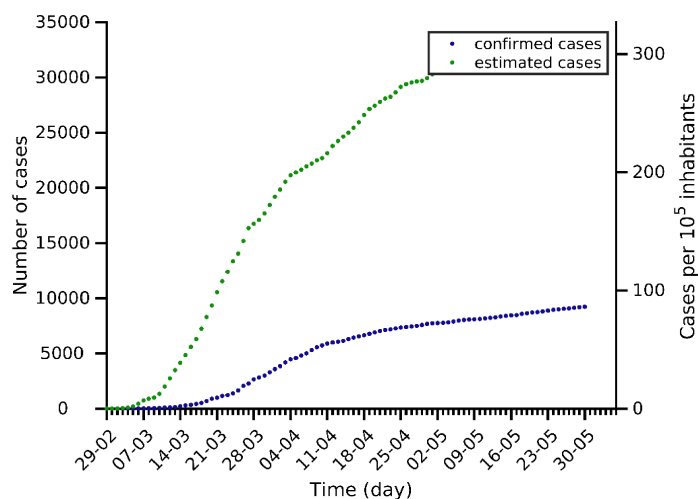
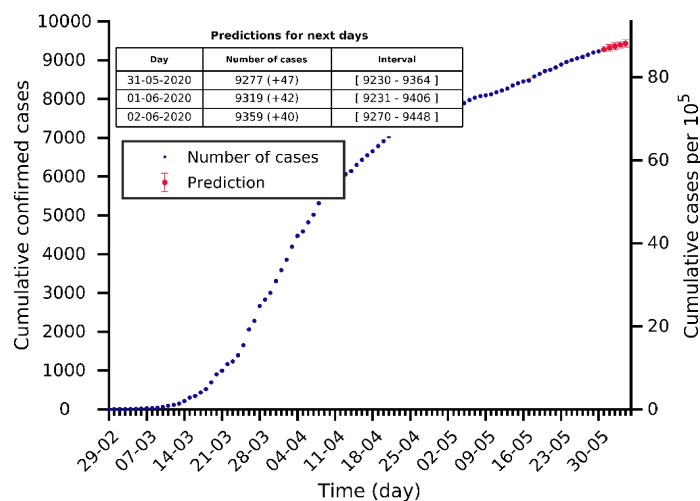
# Austria 30-05-2020. Population: 9.0M. Current cumulated incidence: 185/10<sup>5</sup>



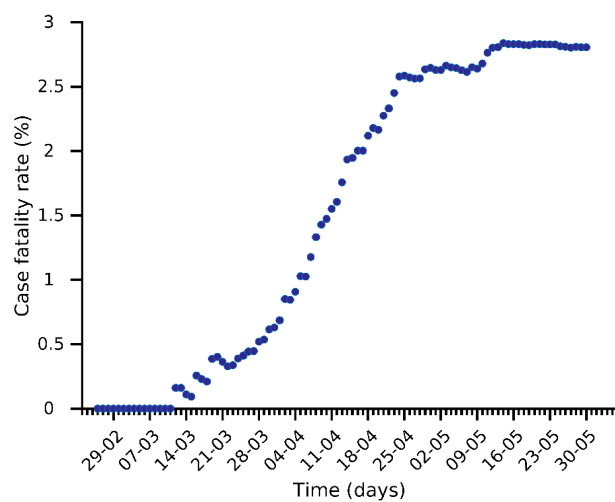
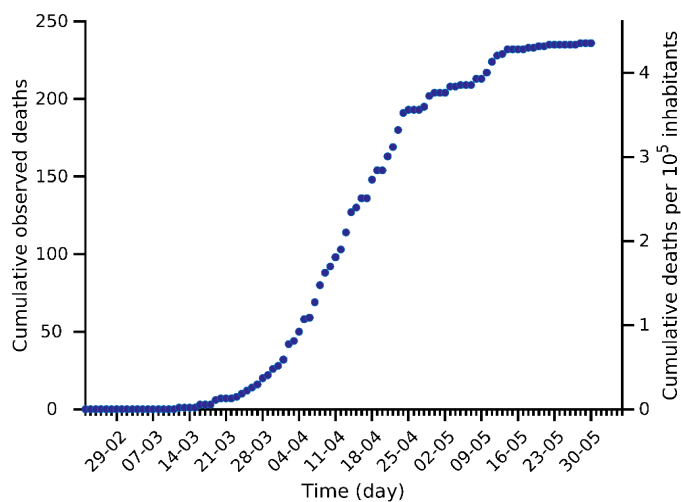
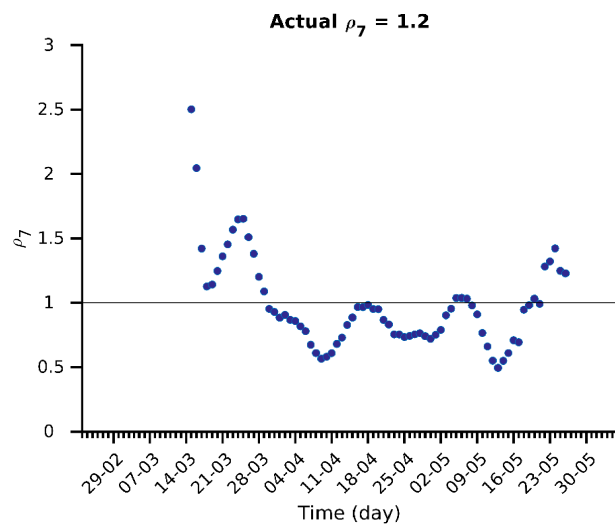
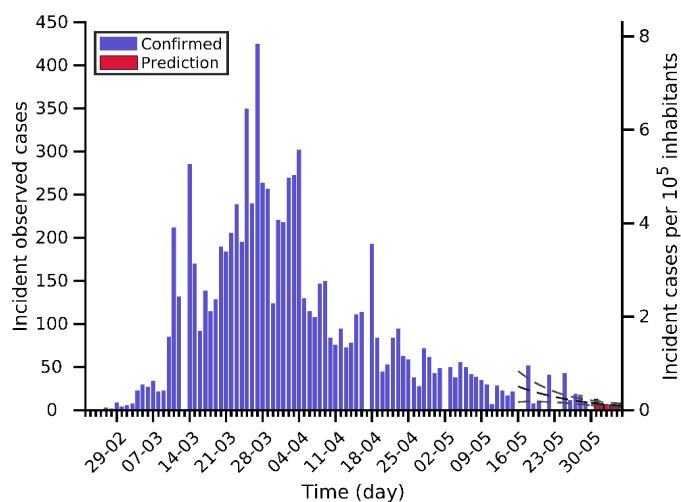
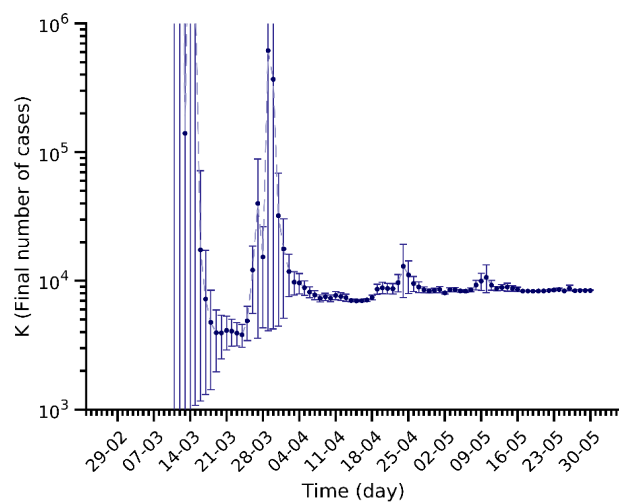
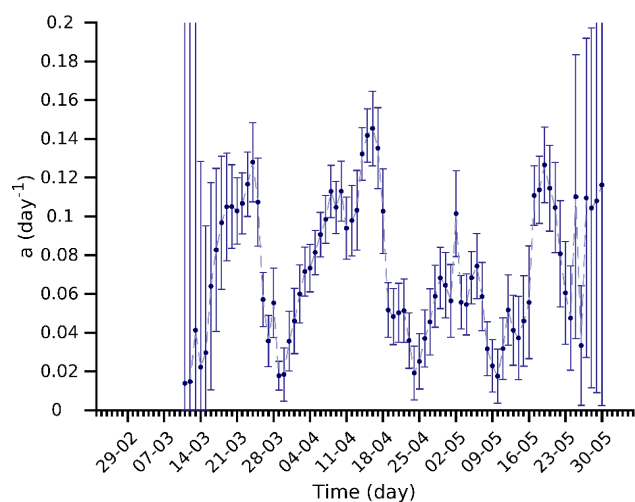
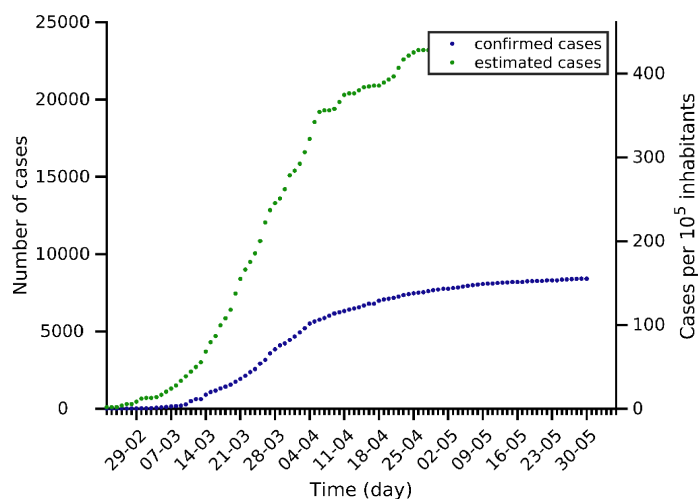
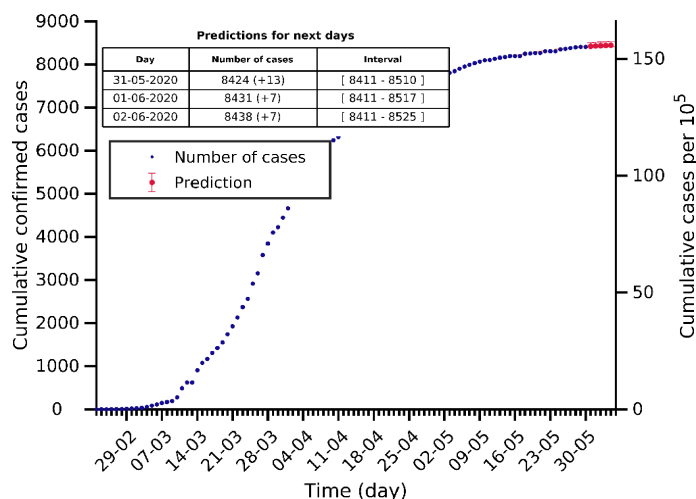
# Denmark 30-05-2020. Population: 5.8M. Current cumulated incidence: 201/10<sup>5</sup>



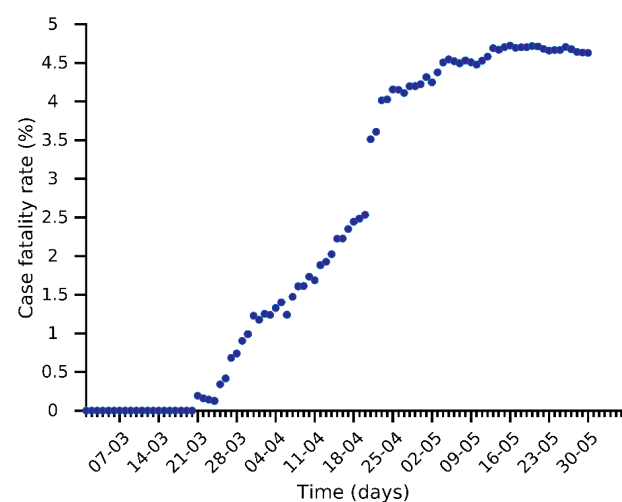
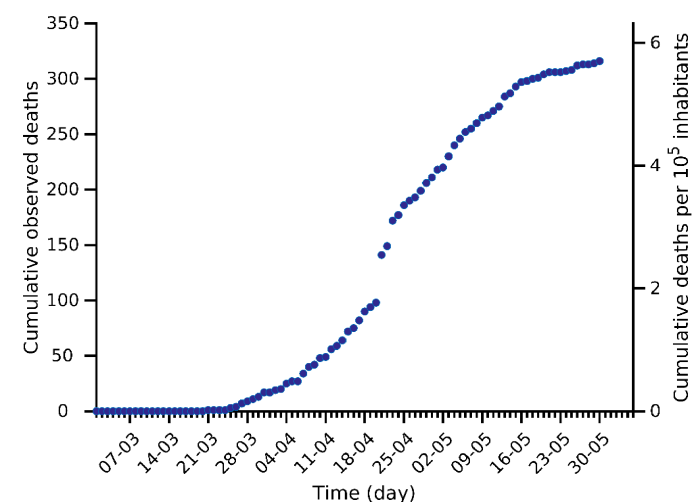
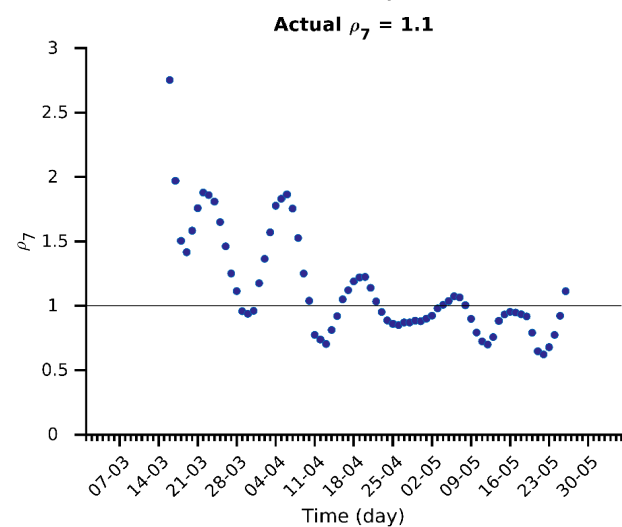
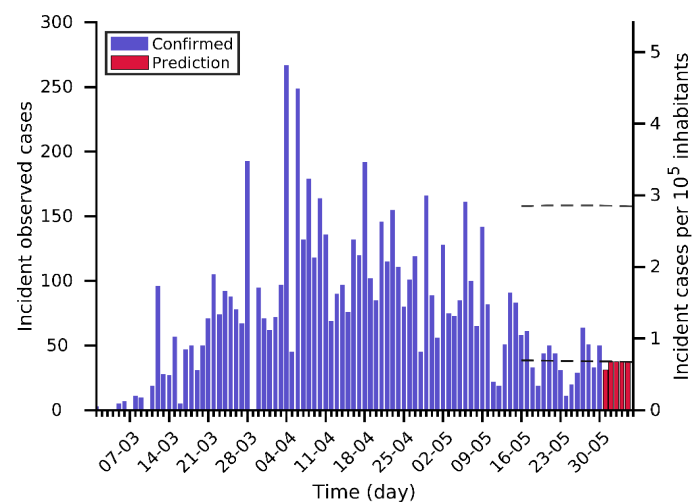
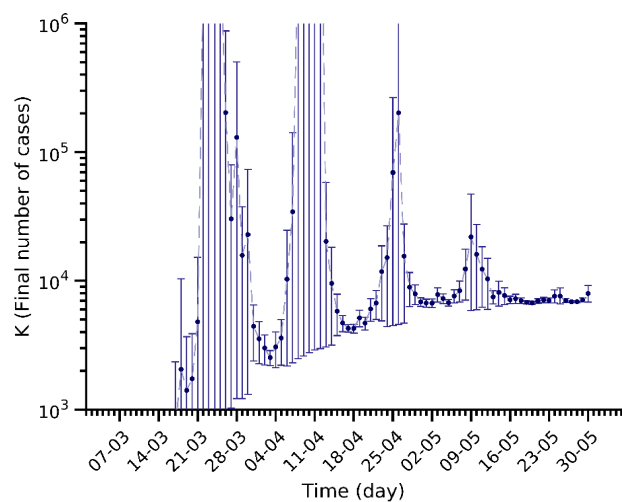
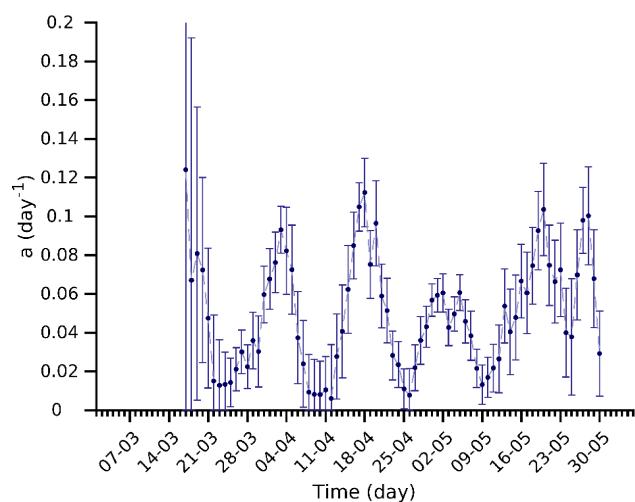
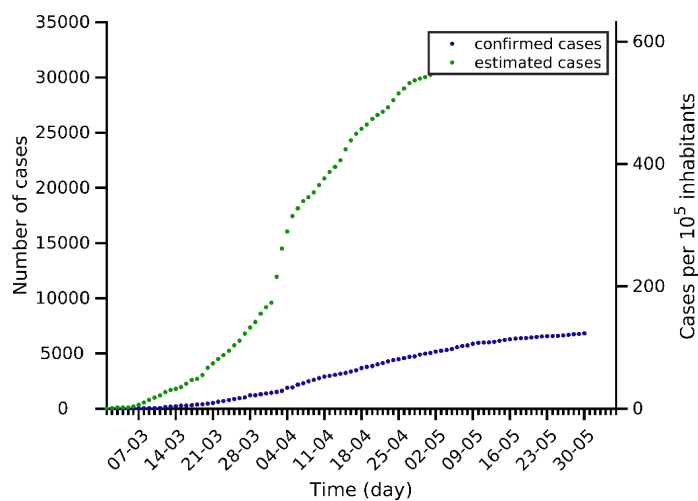
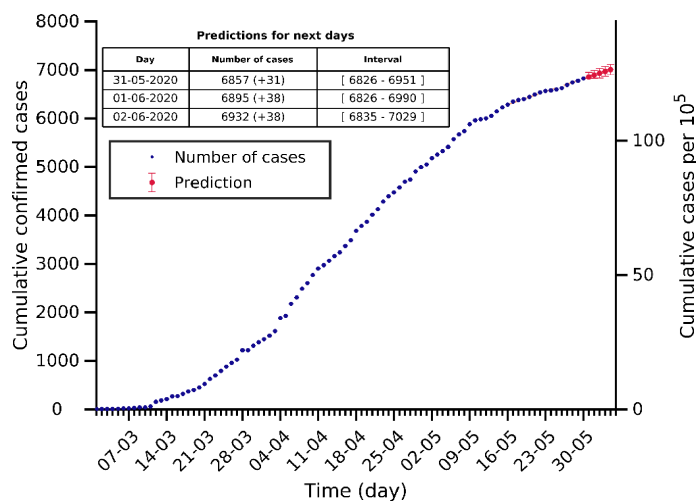
# Czech Rep 30-05-2020. Population: 10.7M. Current cumulated incidence: 86/10<sup>5</sup>



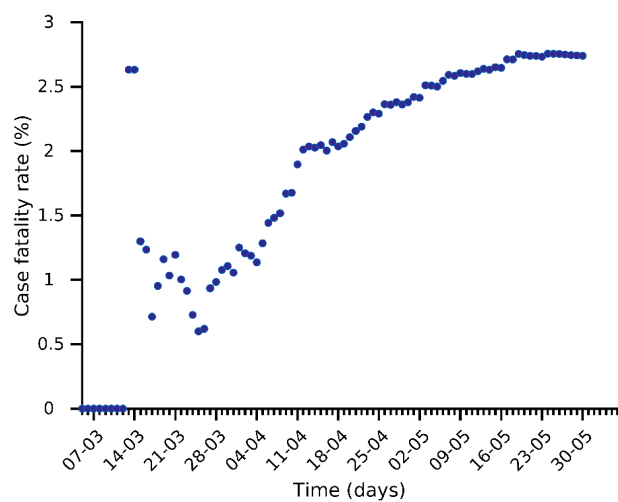
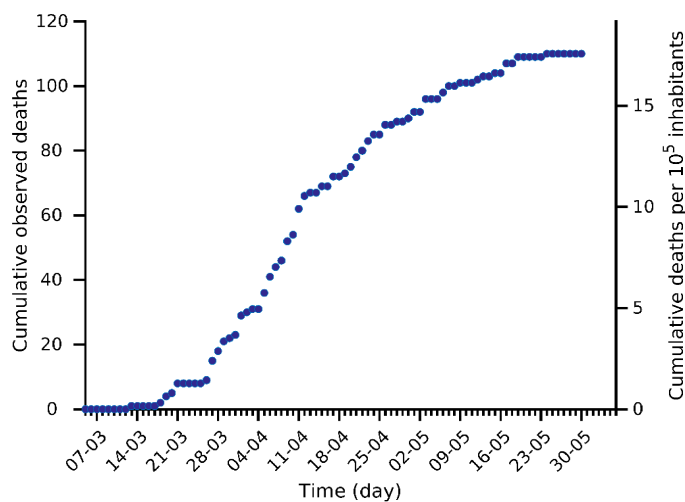
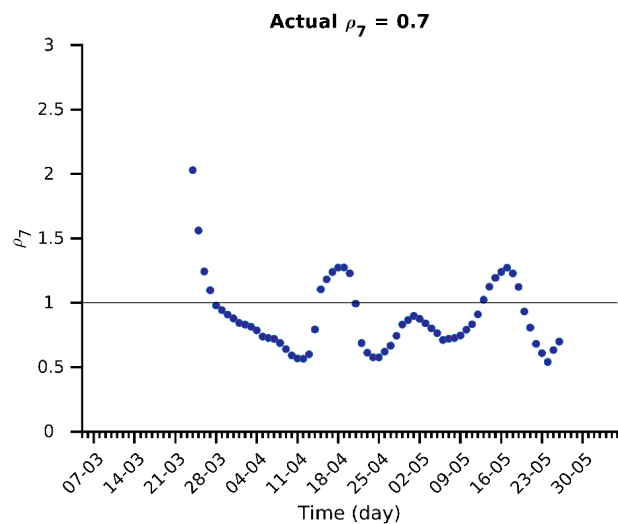
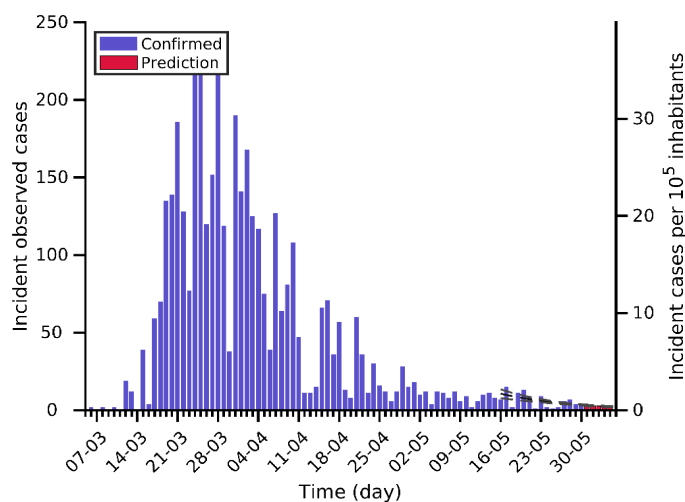
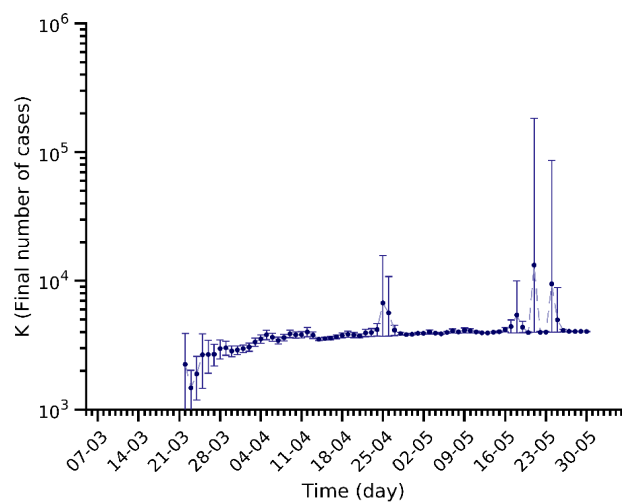
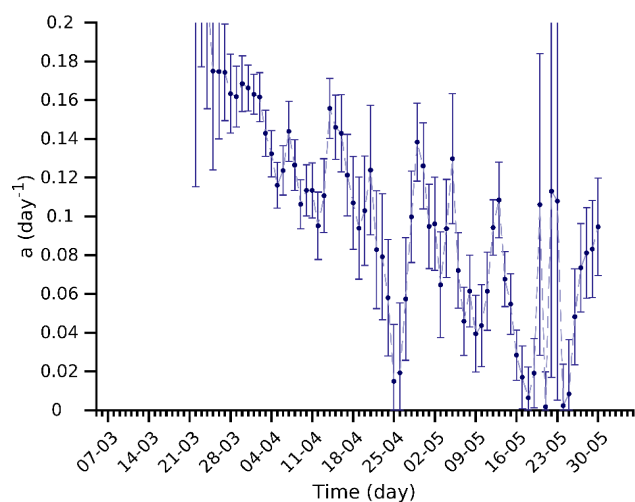
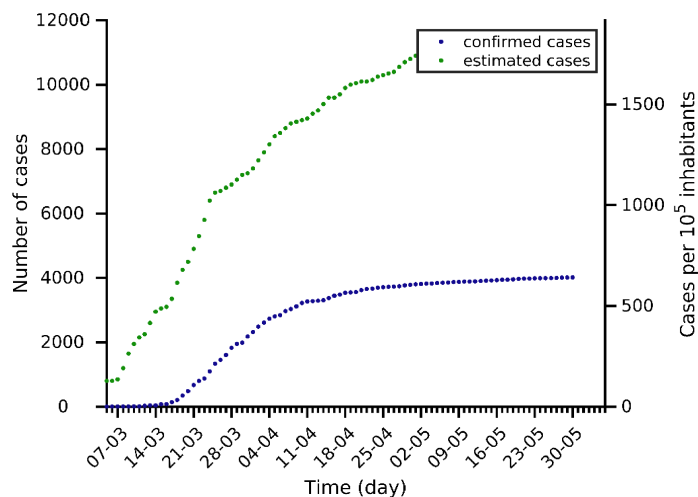
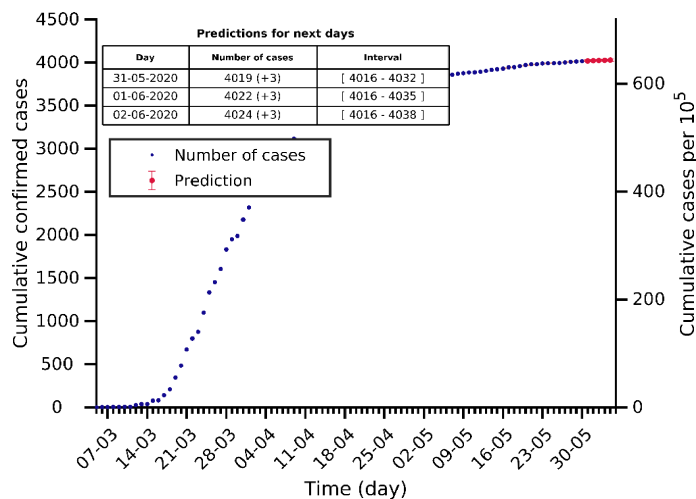
# Norway 30-05-2020. Population: 5.4M. Current cumulated incidence: 155/10<sup>5</sup>



# Finland 30-05-2020. Population: 5.5M. Current cumulated incidence: 123/10<sup>5</sup>

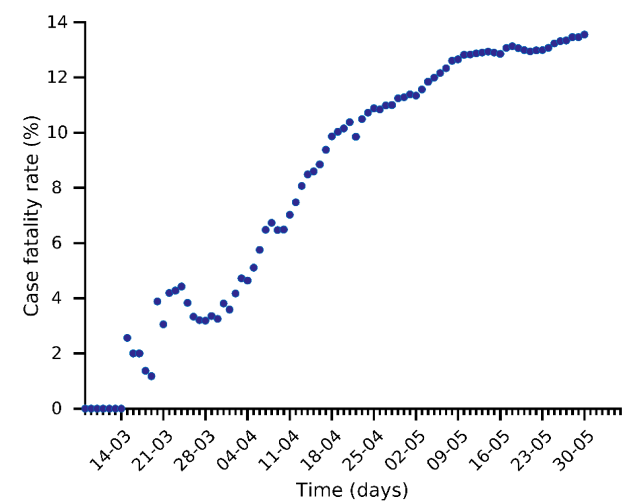
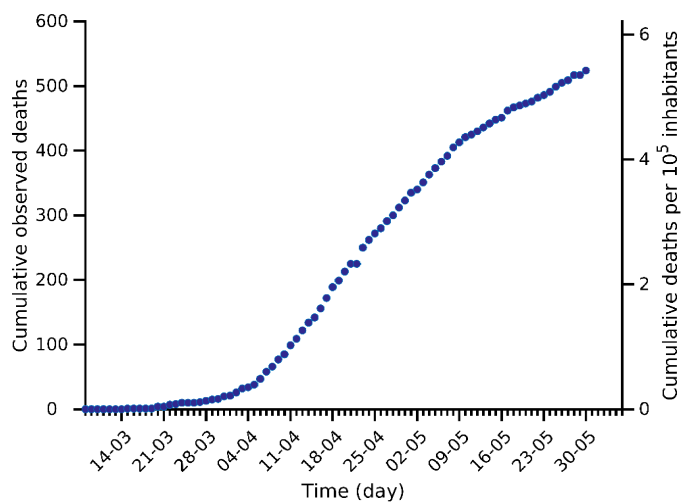
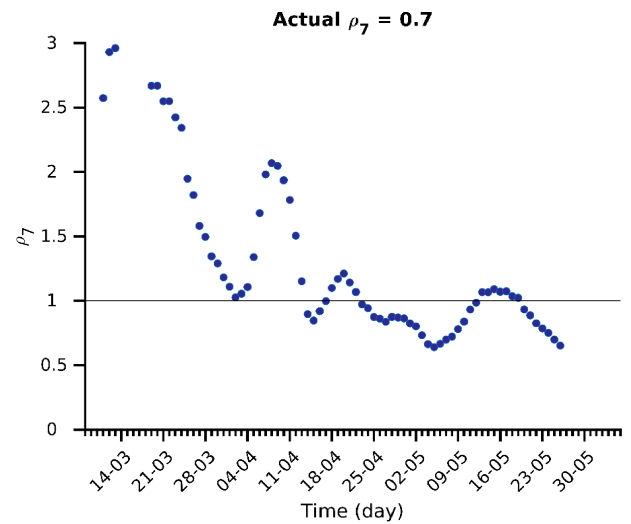
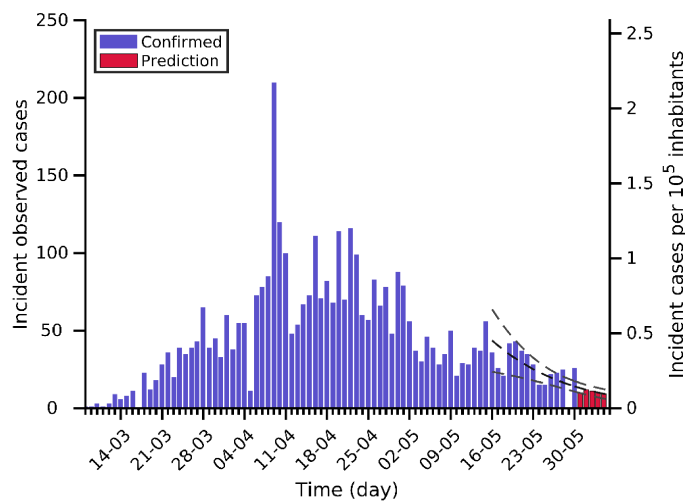
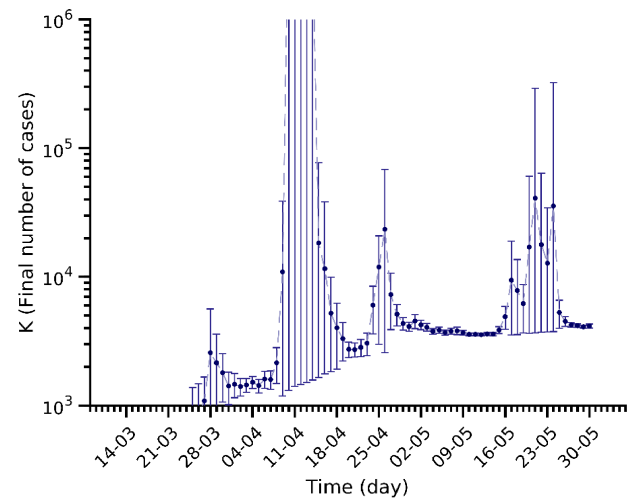
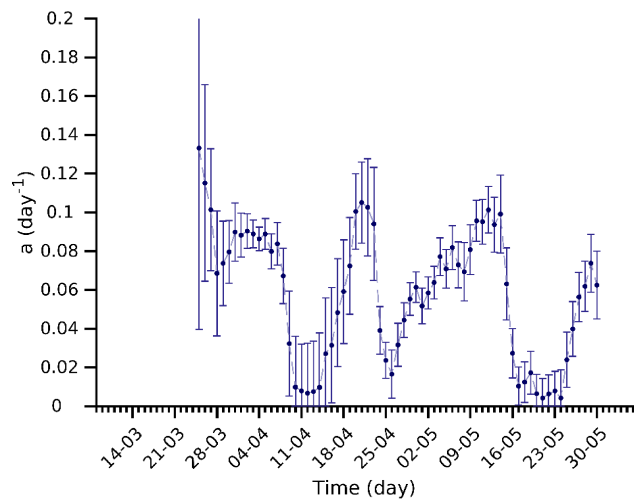
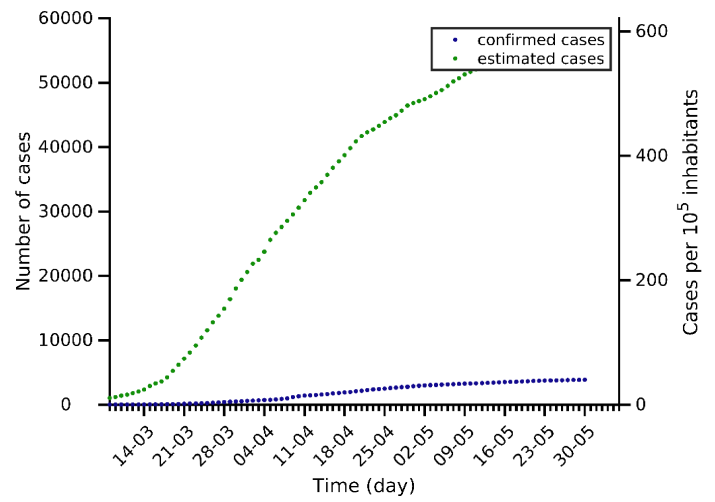
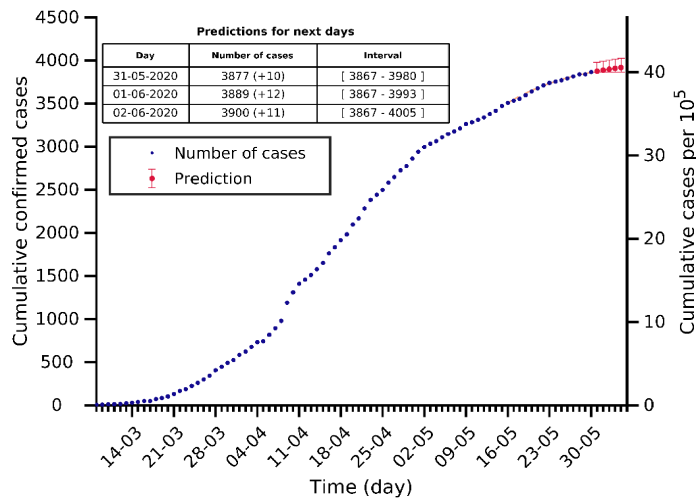


# Luxembourg 30-05-2020. Population: 0.6M. Current cumulated incidence: 642/10<sup>5</sup>

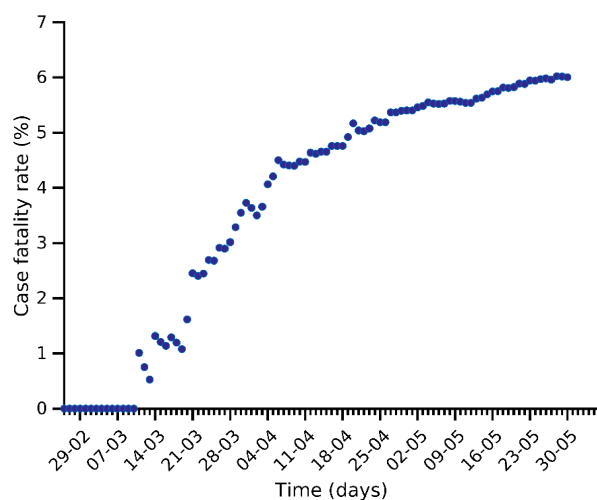
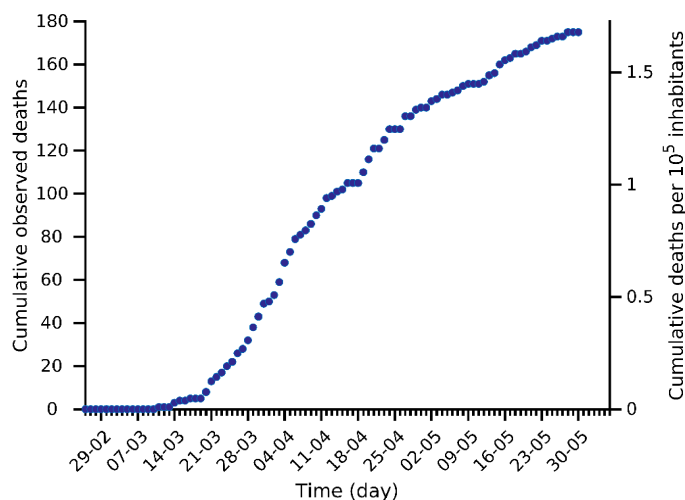
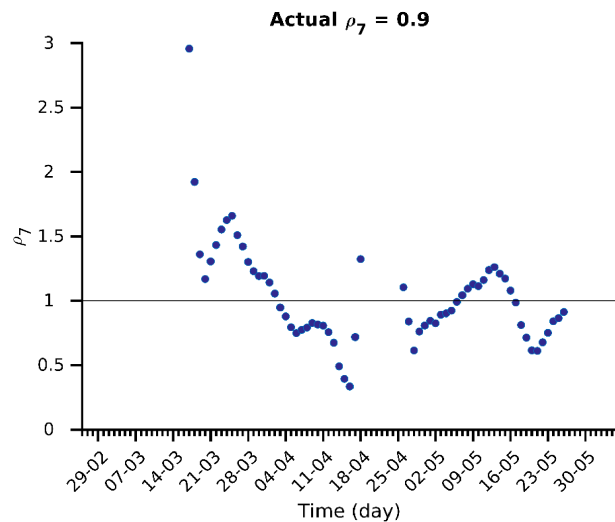
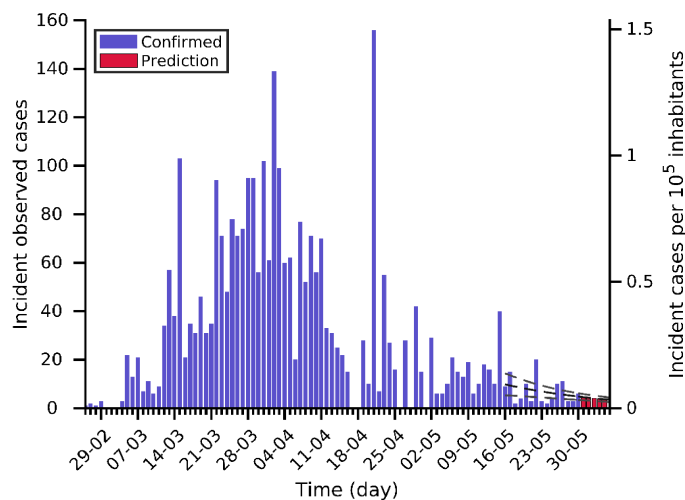
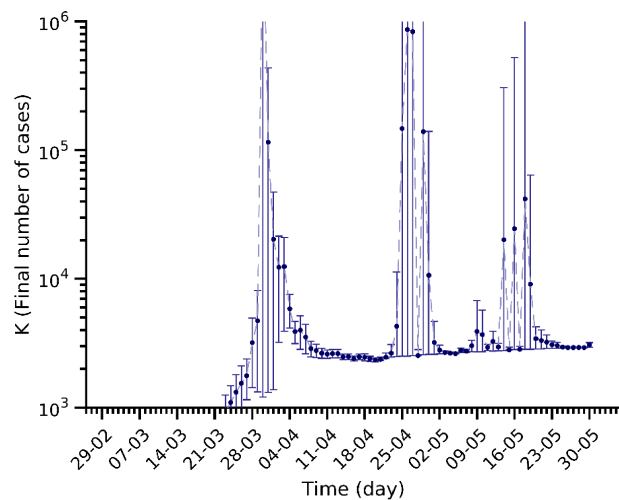
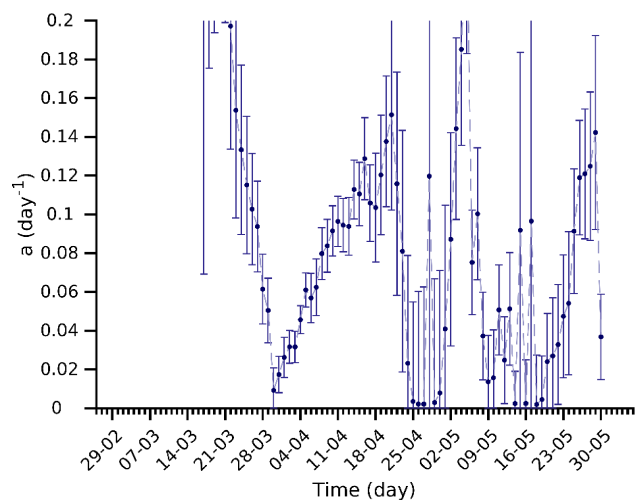
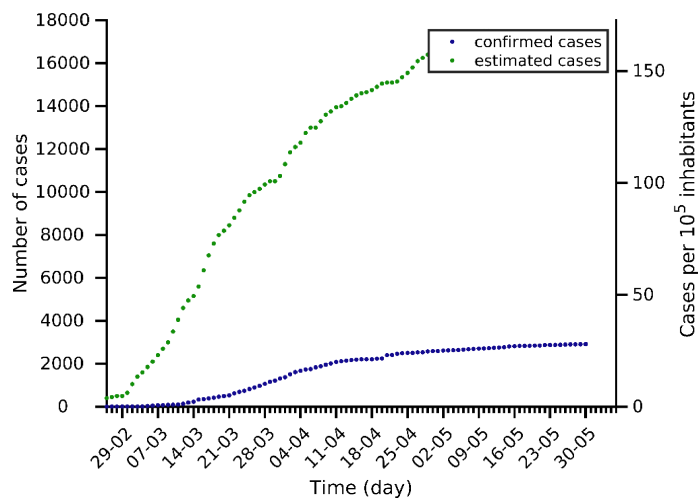
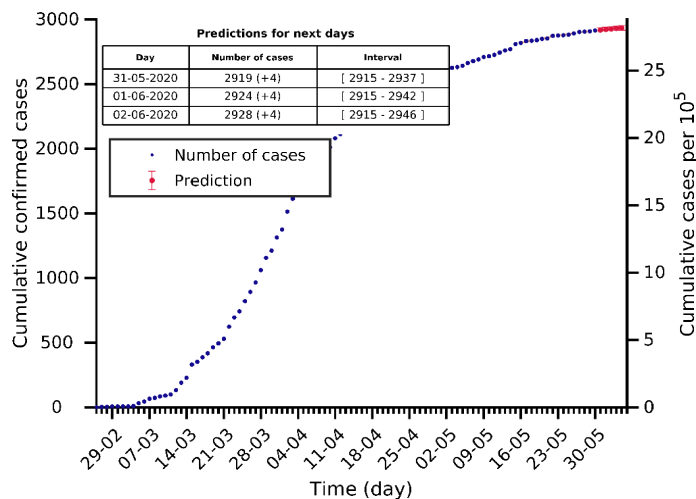




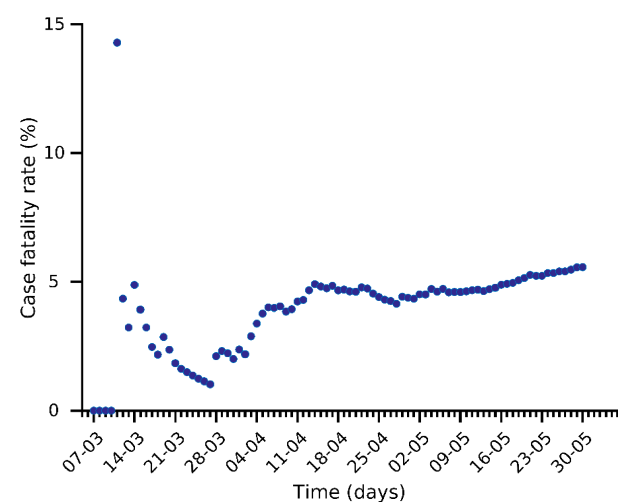
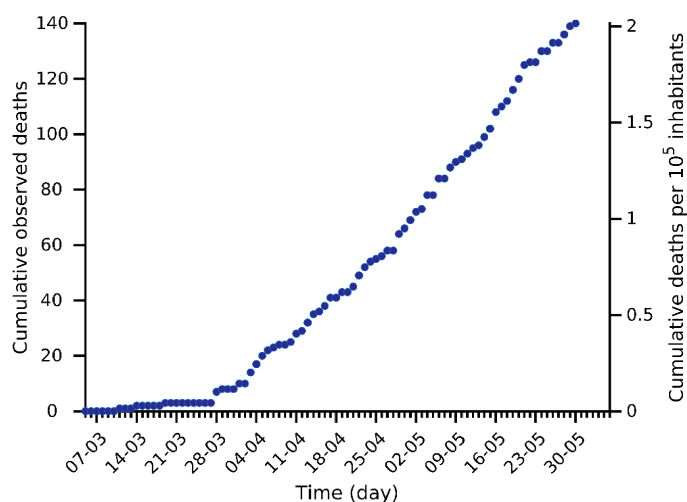
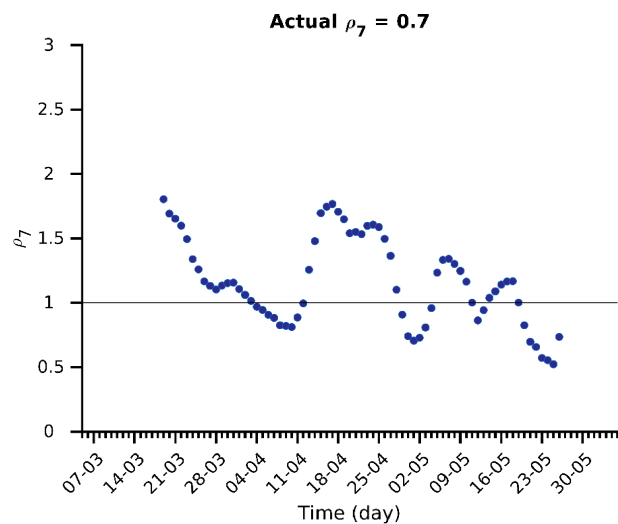
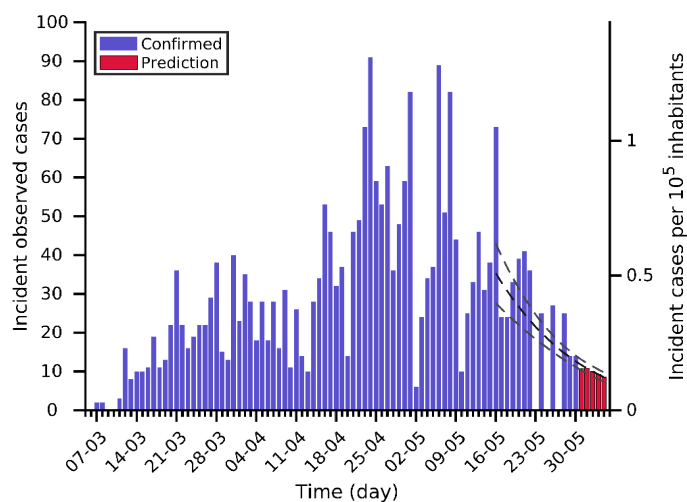
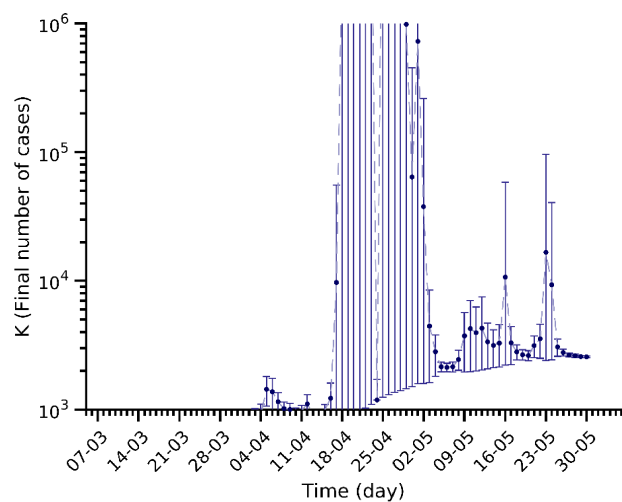
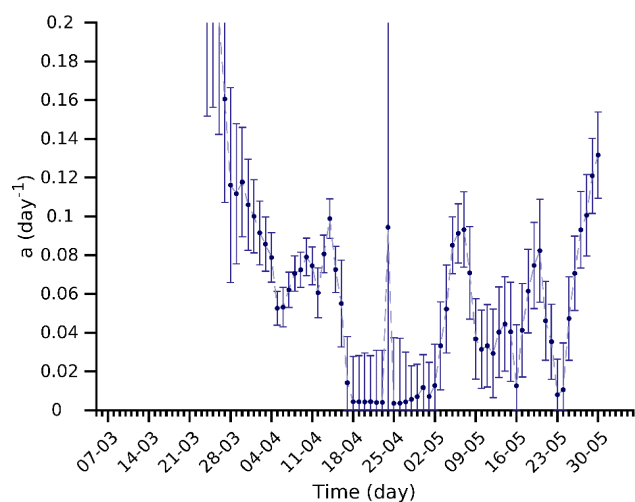
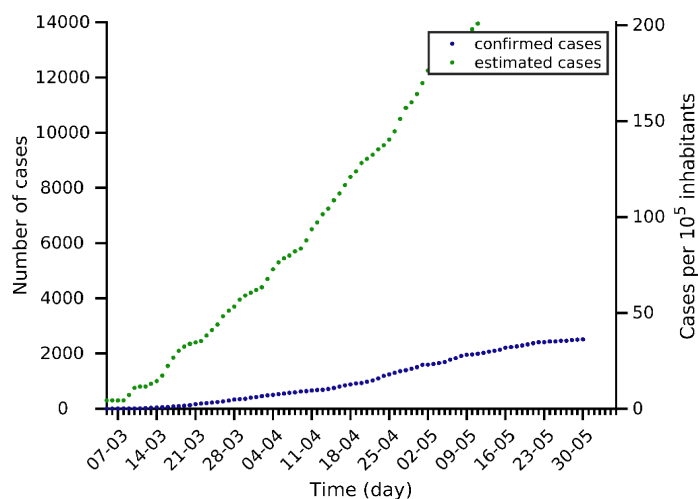
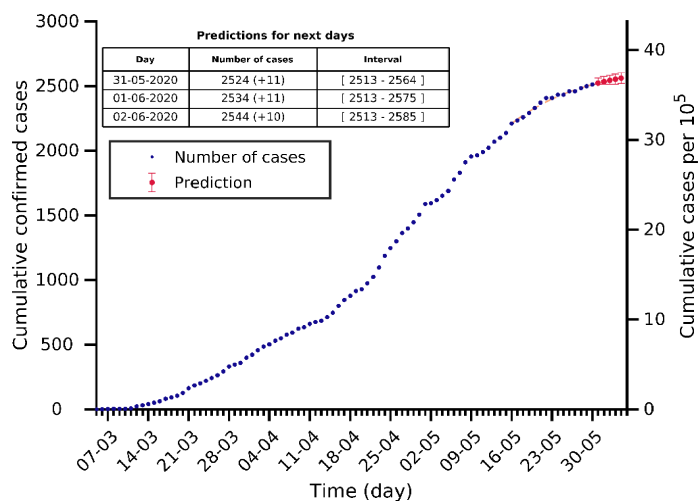
# Hungary 30-05-2020. Population: 9.7M. Current cumulated incidence: 40/10<sup>5</sup>



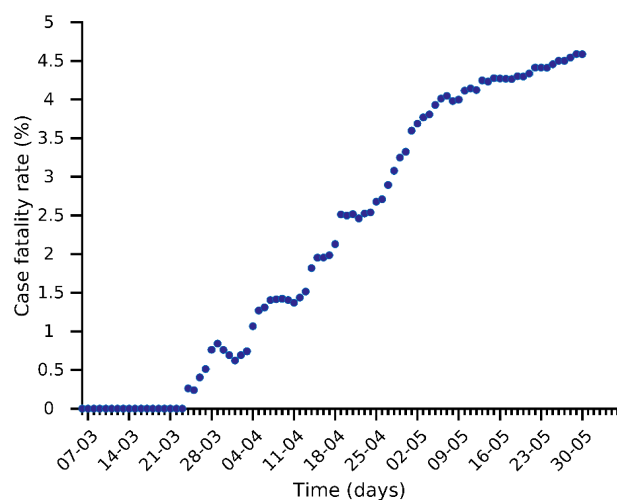
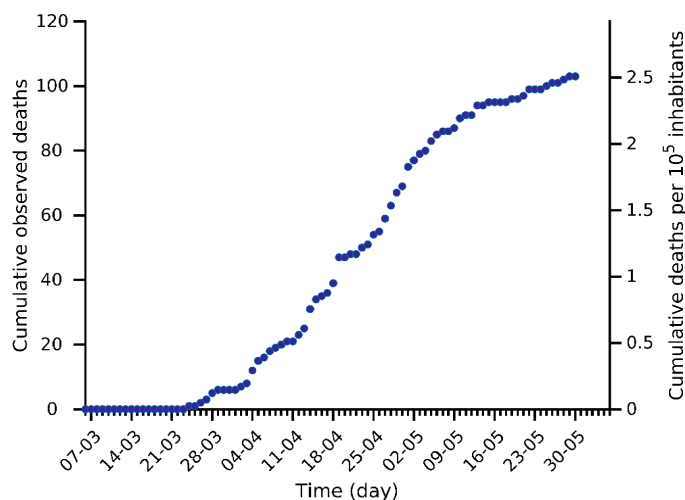
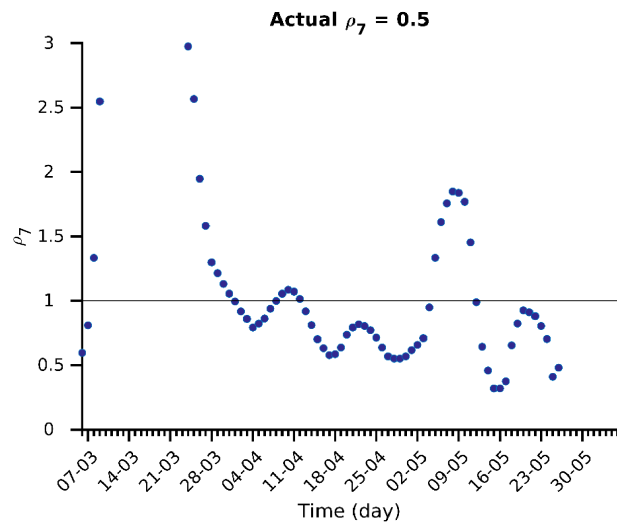
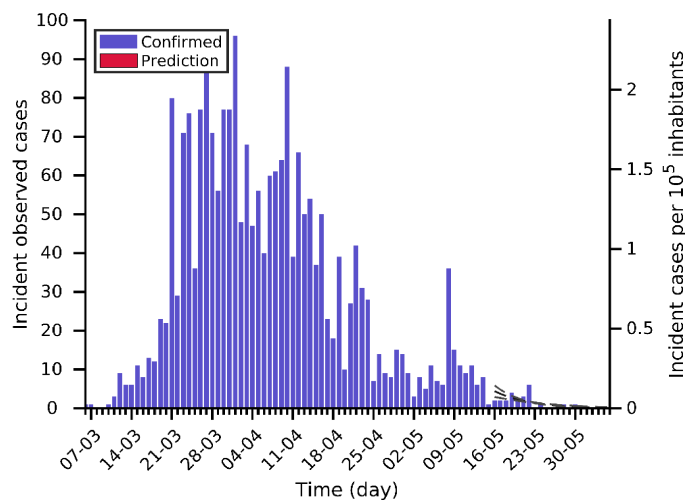
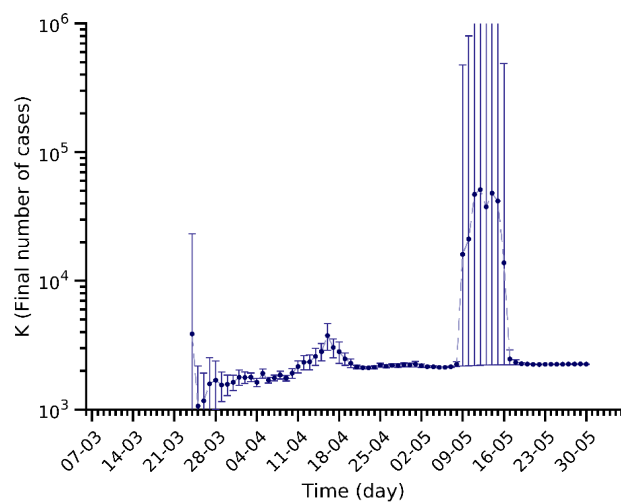
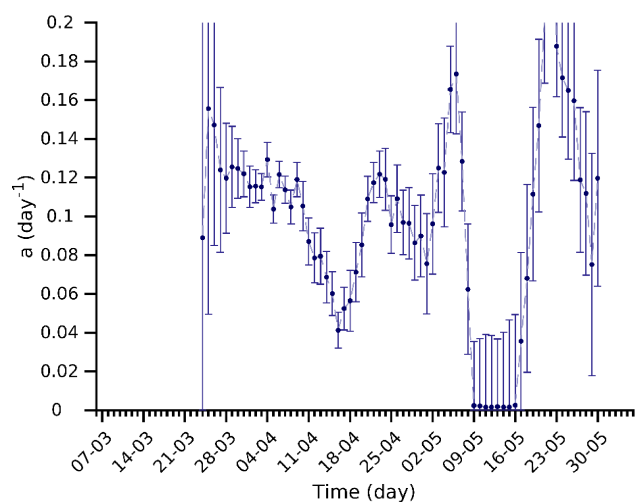
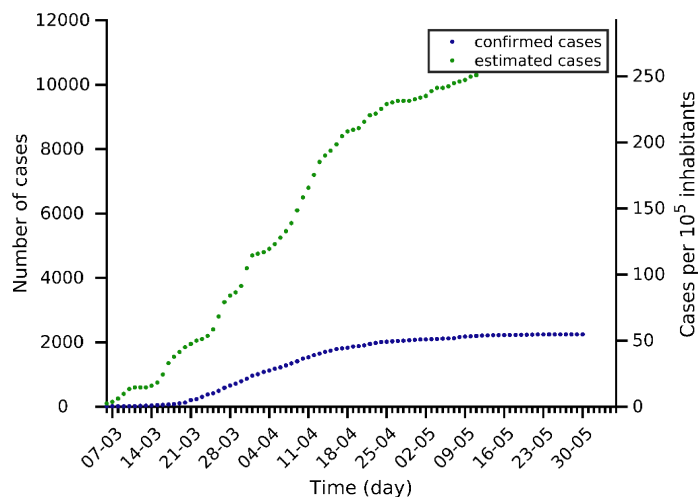
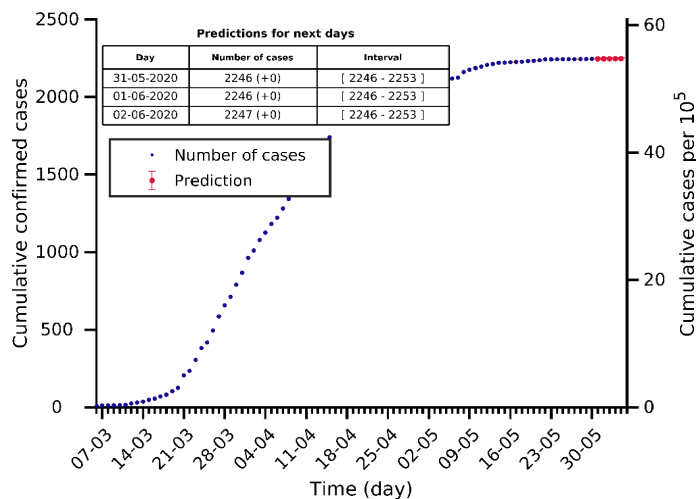
# Greece 30-05-2020. Population: 10.4M. Current cumulated incidence: 28/10<sup>5</sup>



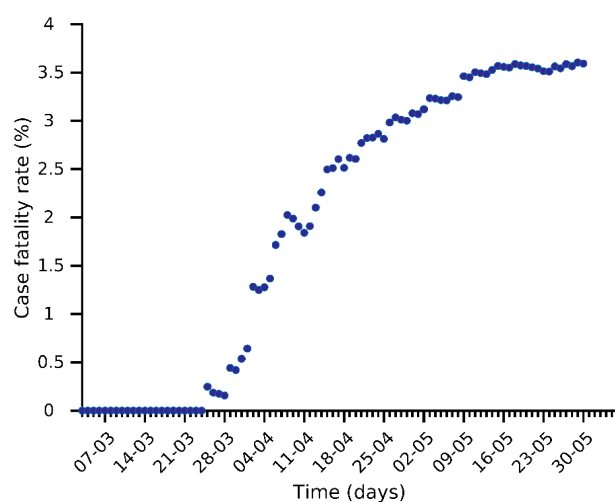
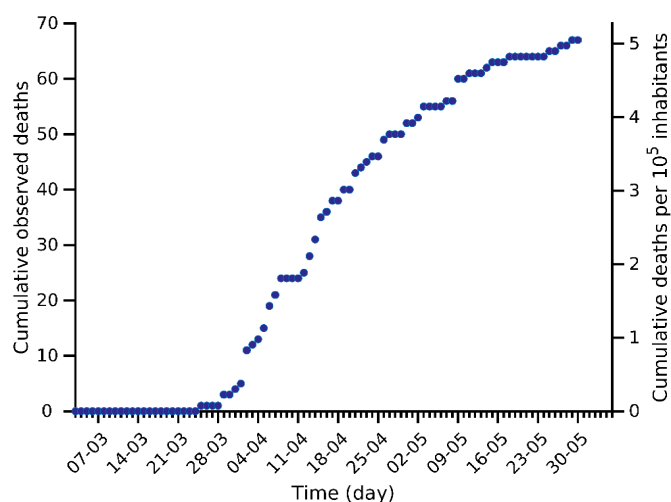
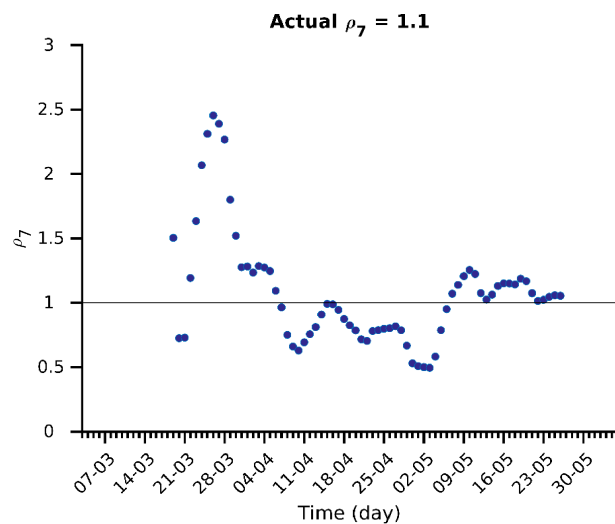
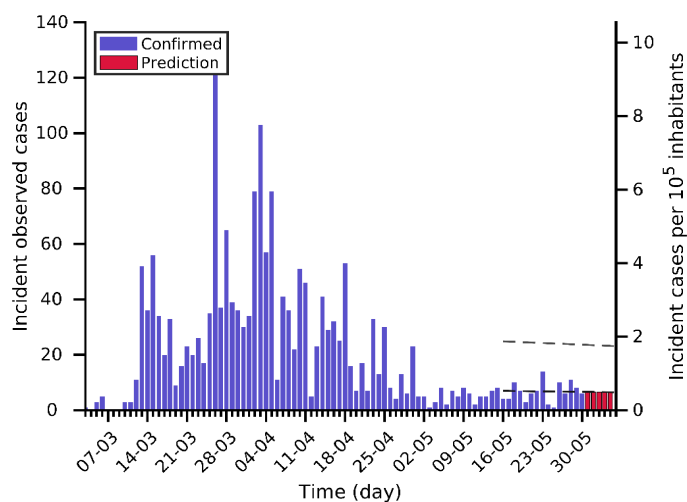
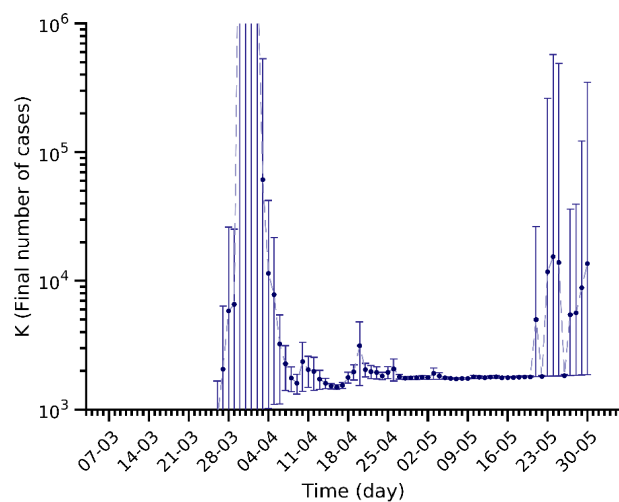
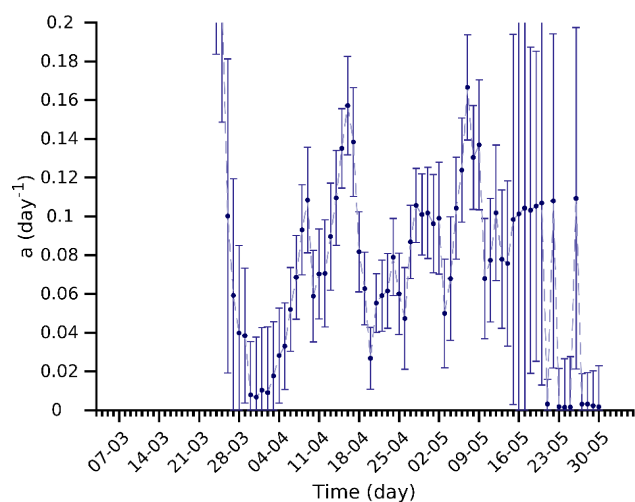
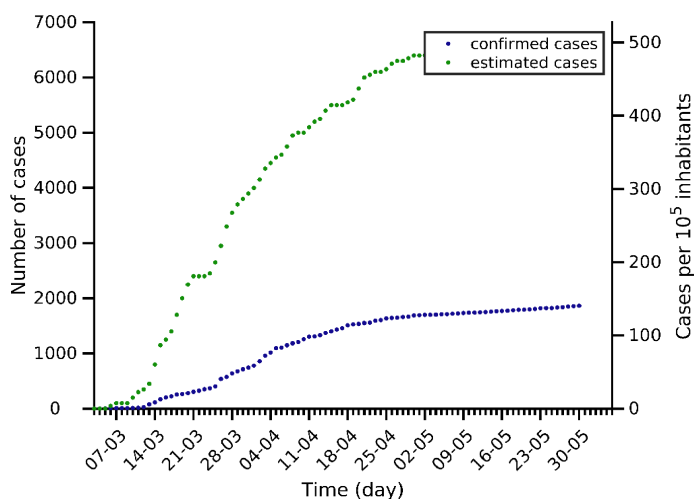
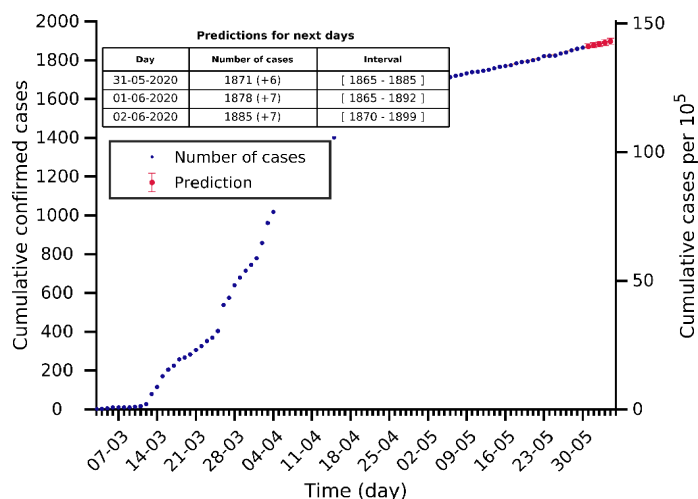
# Bulgaria 30-05-2020. Population: 6.9M. Current cumulated incidence: 36/10<sup>5</sup>



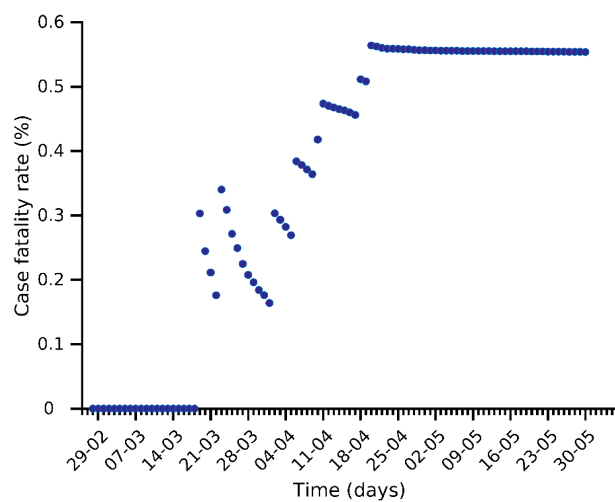
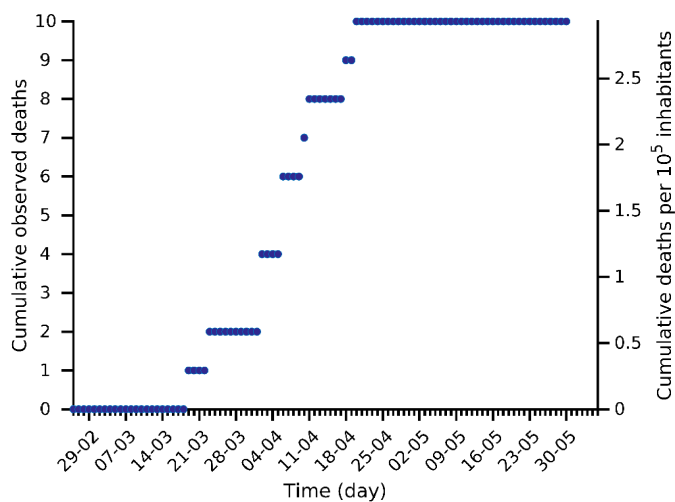
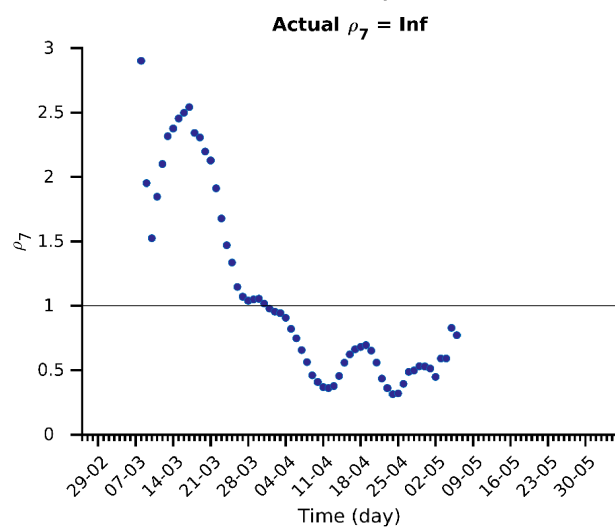
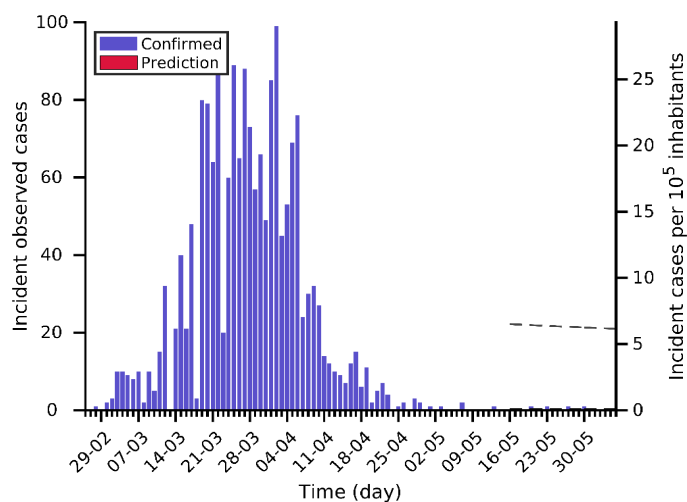
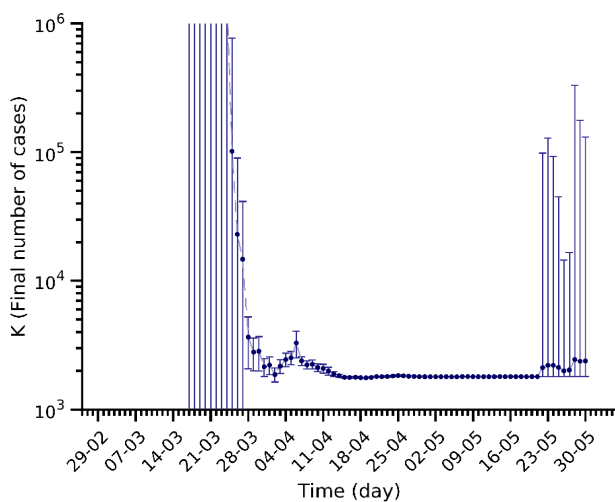
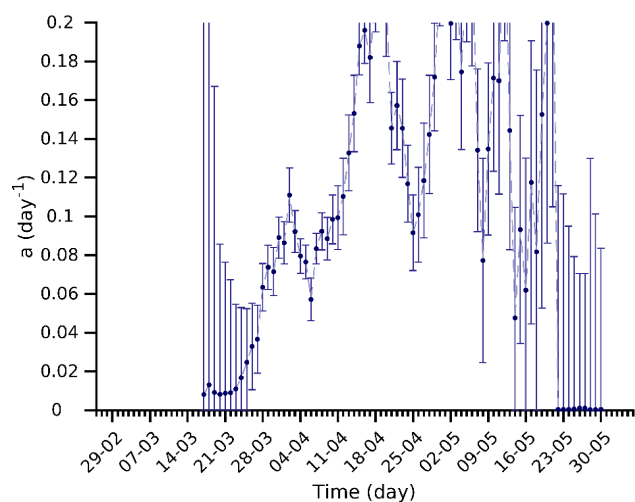
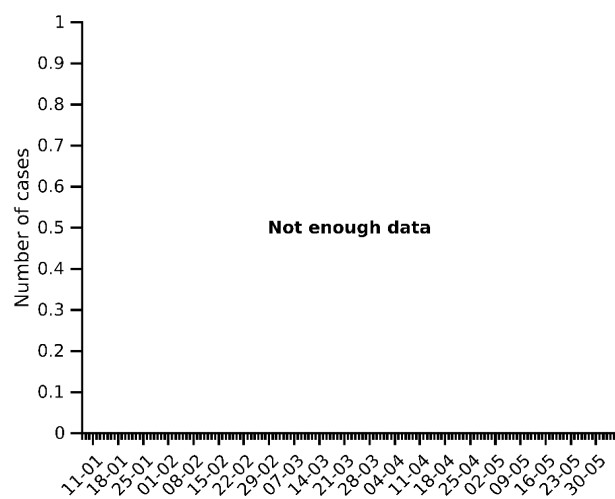
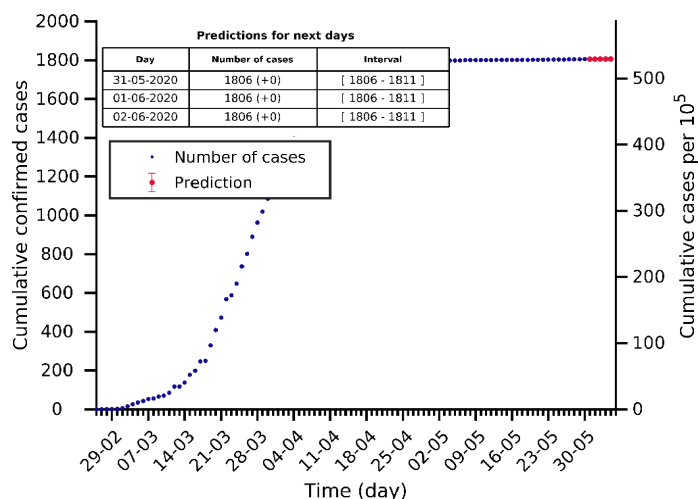
# Croatia 30-05-2020. Population: 4.1M. Current cumulated incidence: 55/10<sup>5</sup>



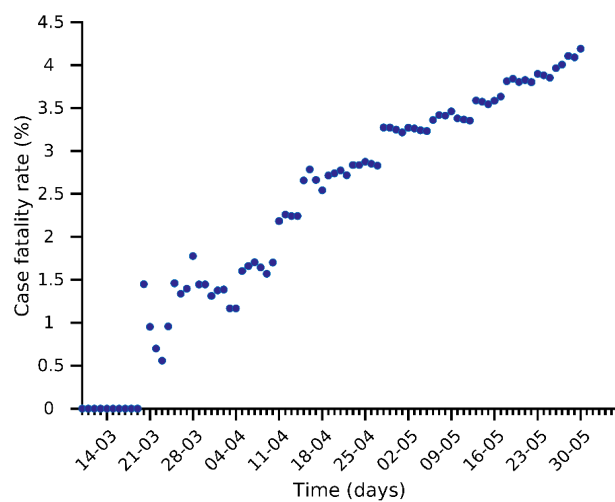
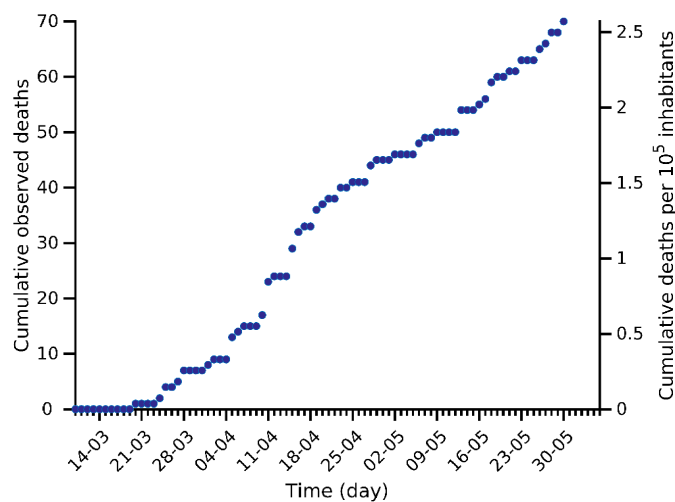
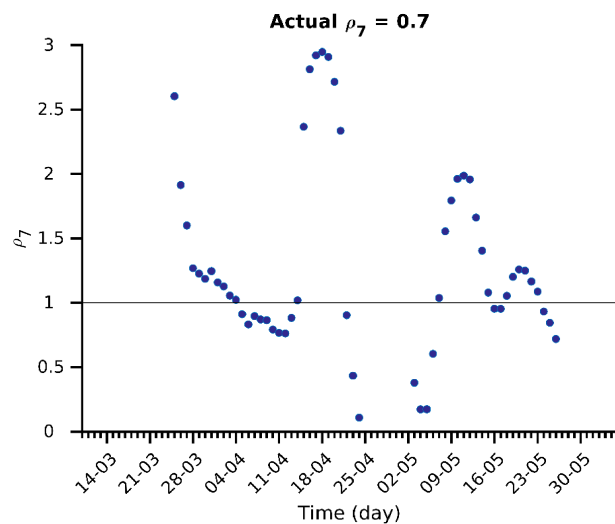
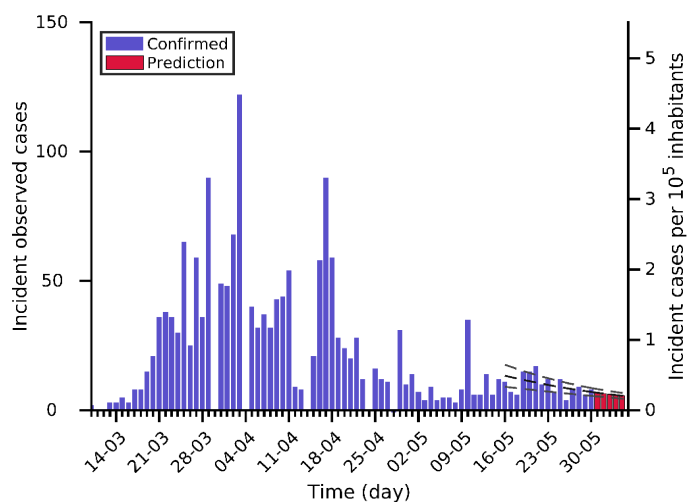
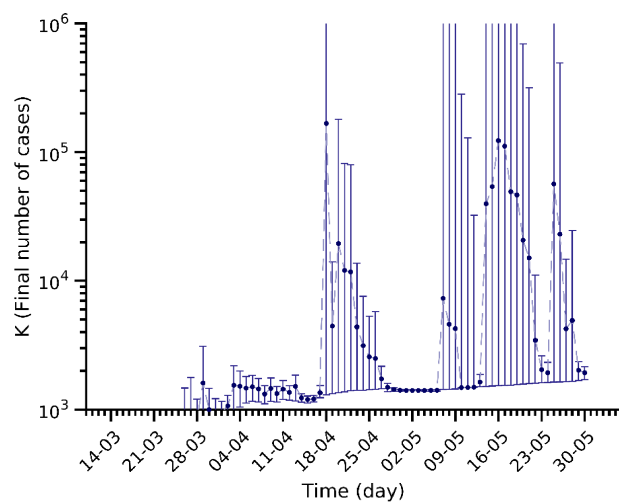
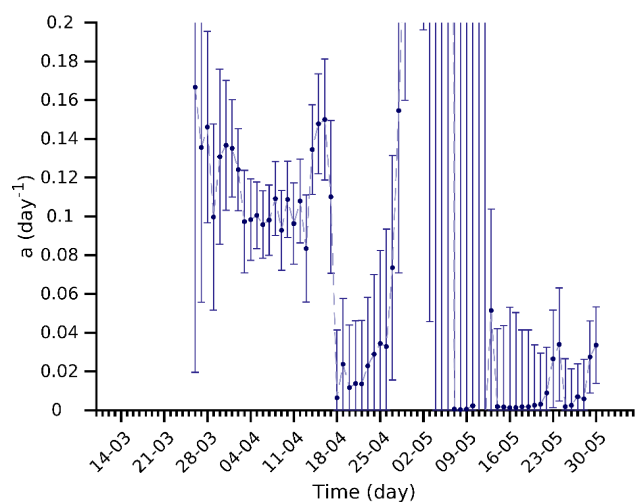
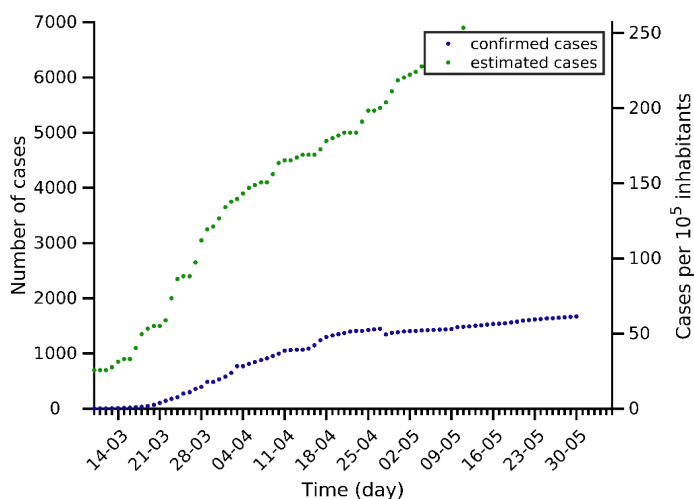
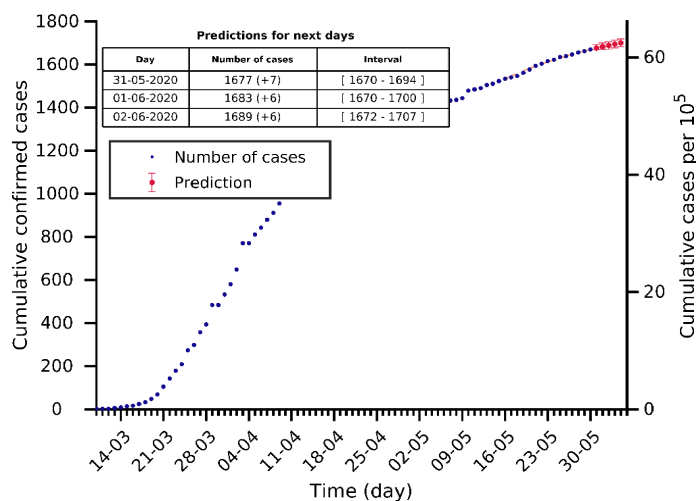
# Estonia 30-05-2020. Population: 1.3M. Current cumulated incidence: 141/10<sup>5</sup>



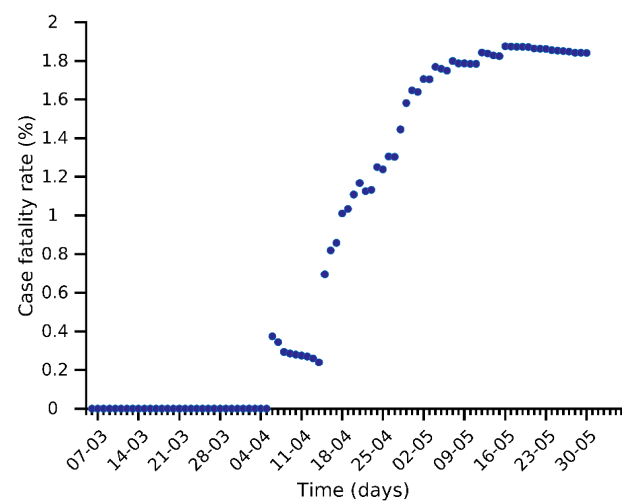
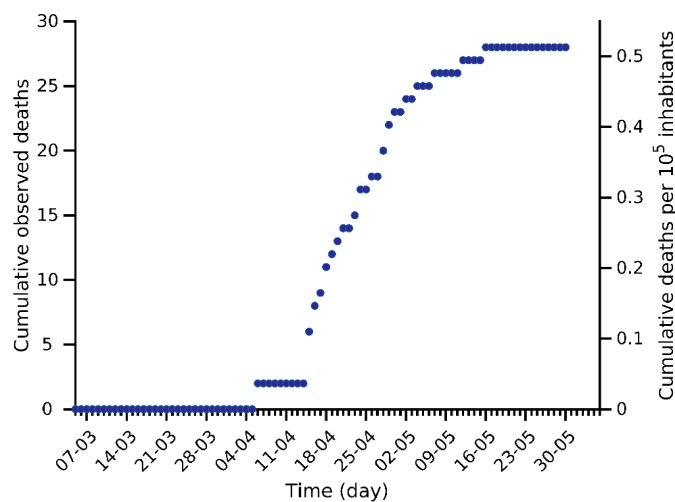
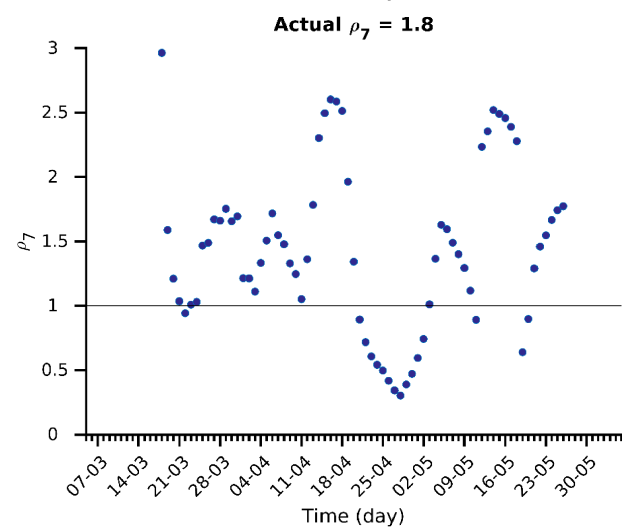
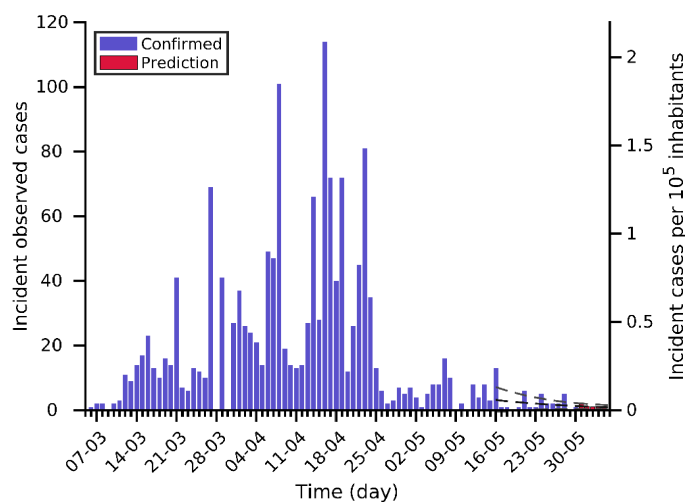
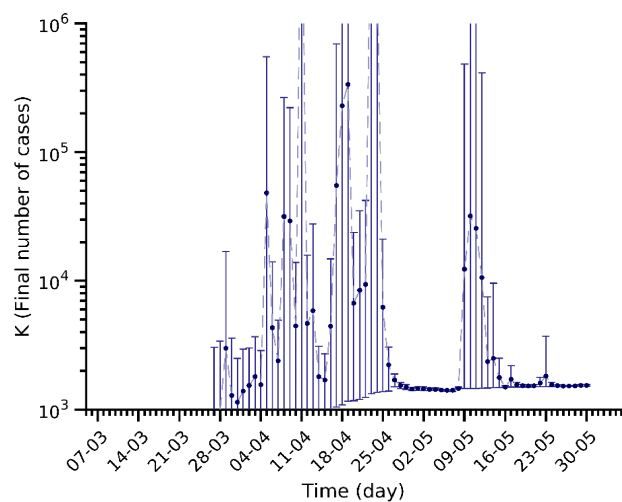
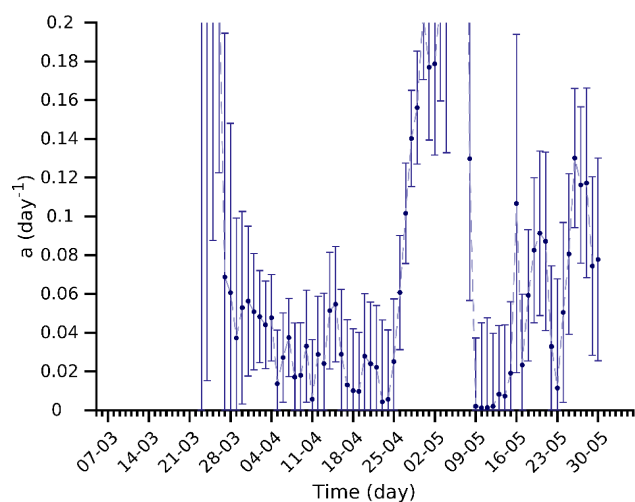
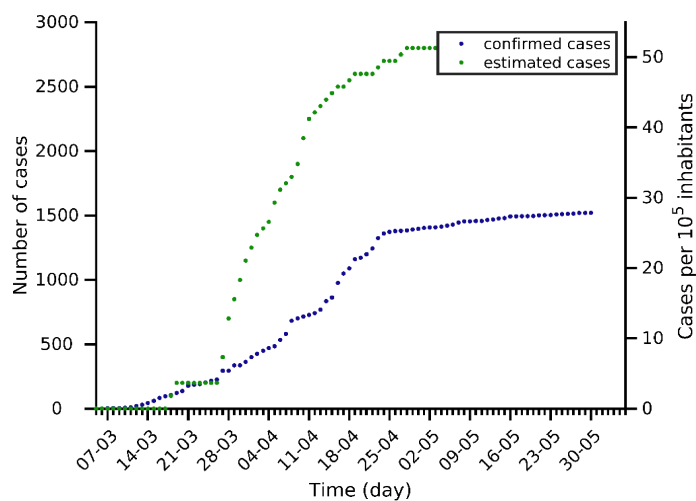
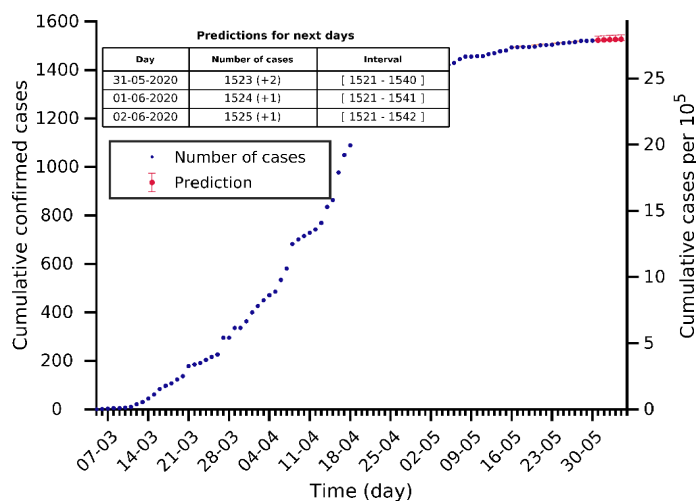
# Iceland 30-05-2020. Population: 0.3M. Current cumulated incidence: 529/10<sup>5</sup>



# Lithuania 30-05-2020. Population: 2.7M. Current cumulated incidence: 61/10<sup>5</sup>

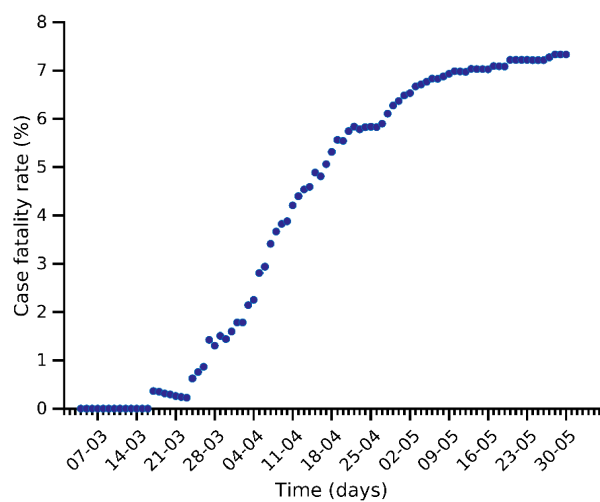
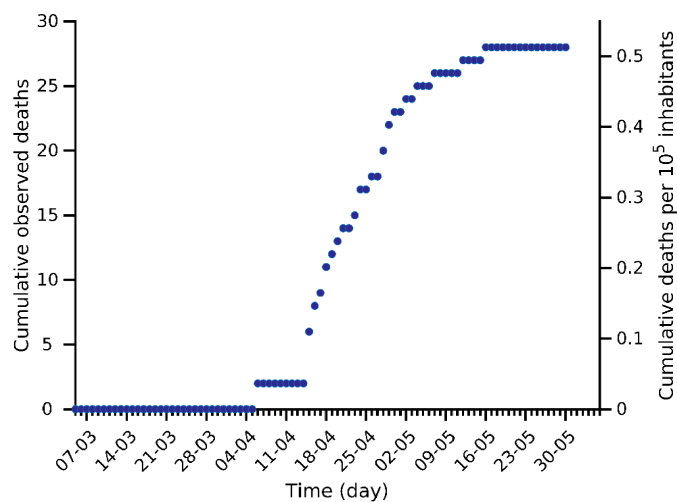
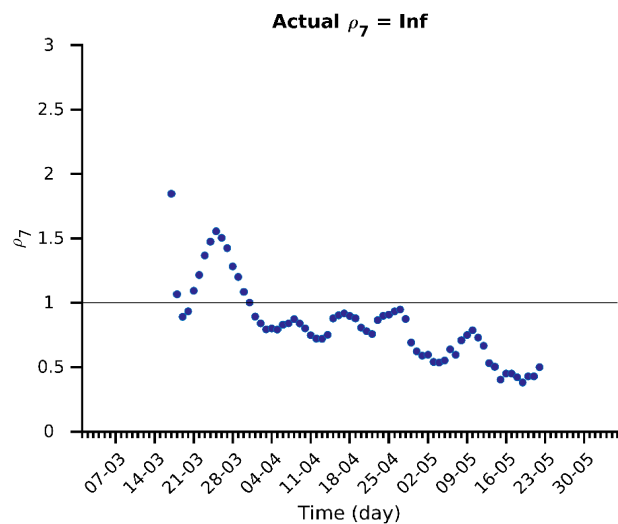
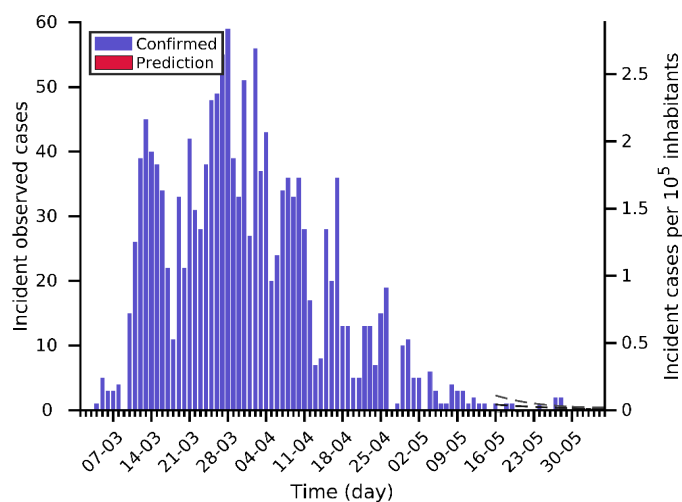
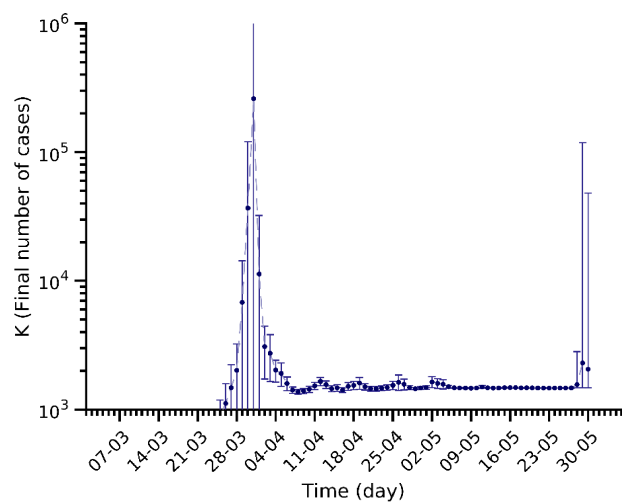
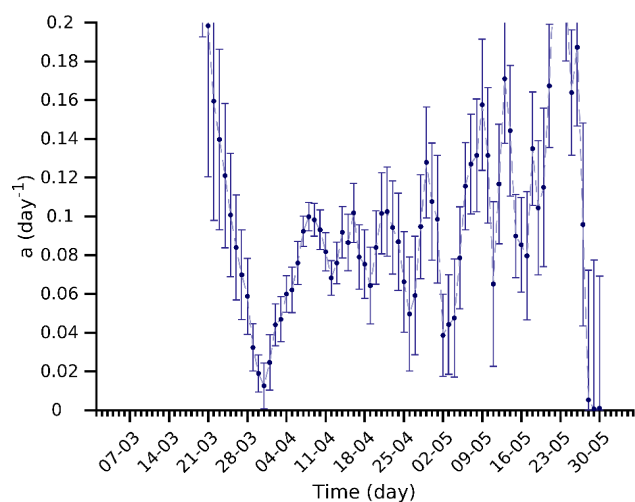
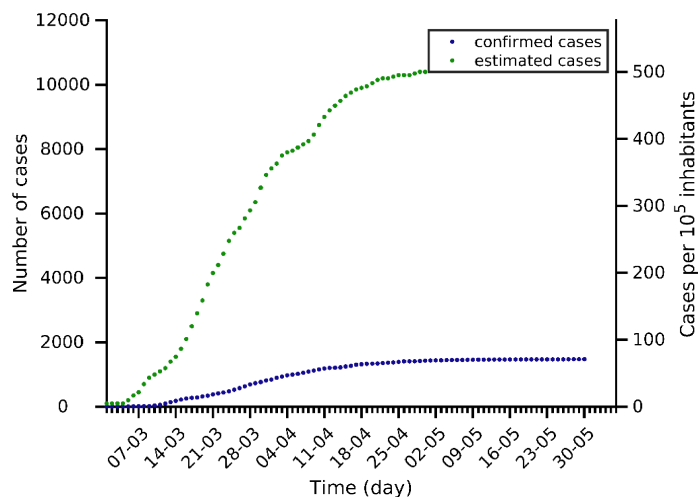
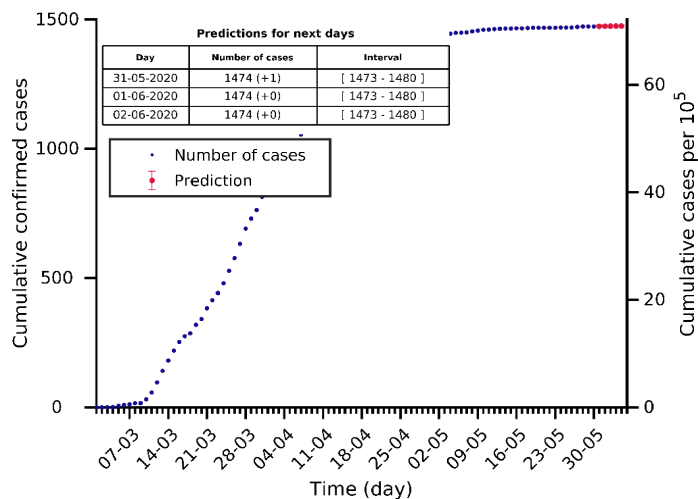


# Slovakia 30-05-2020. Population: 5.5M. Current cumulated incidence: $28/10^5$

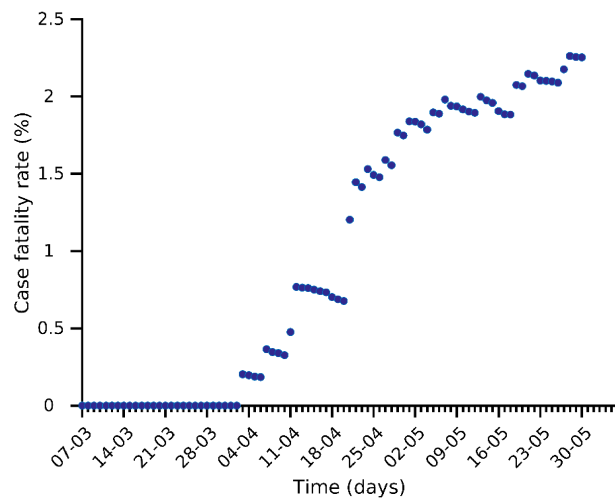
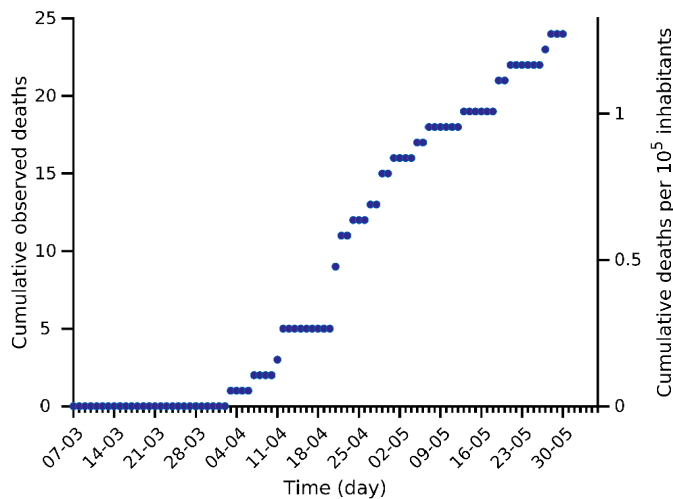
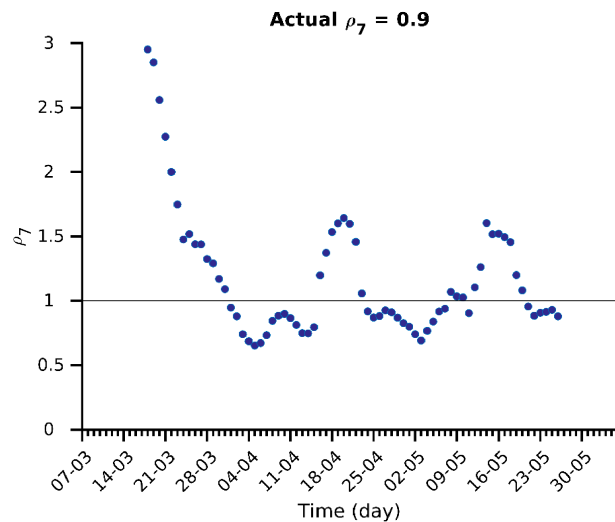
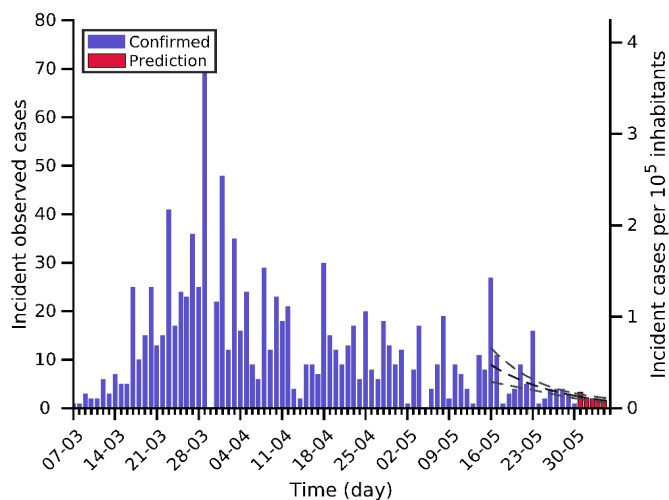
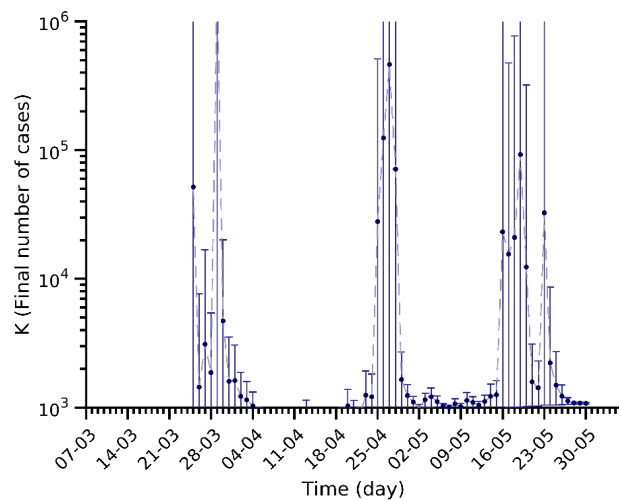
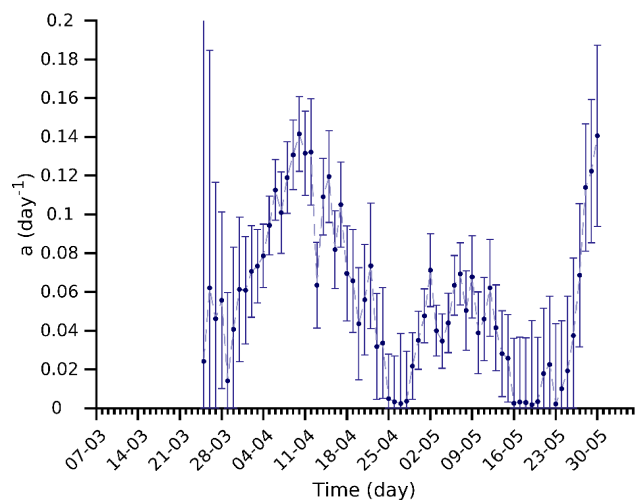
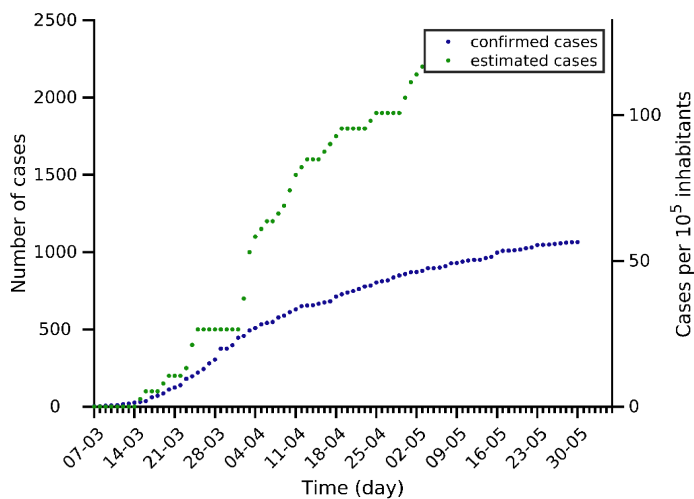
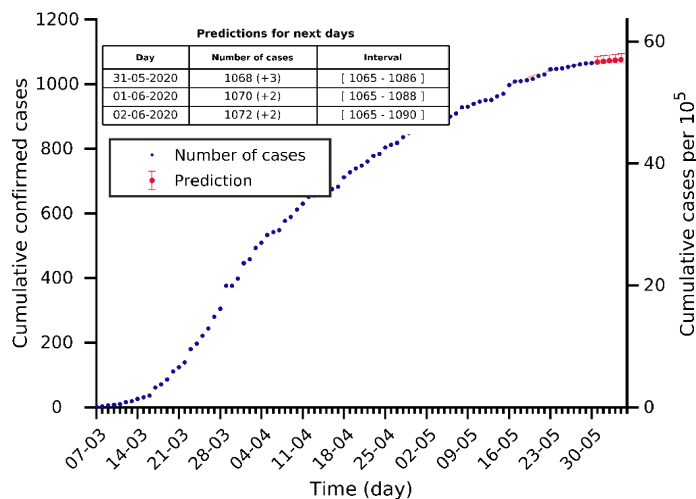




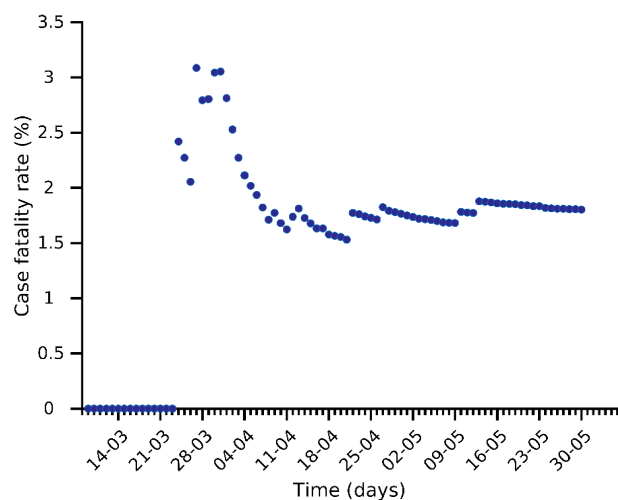
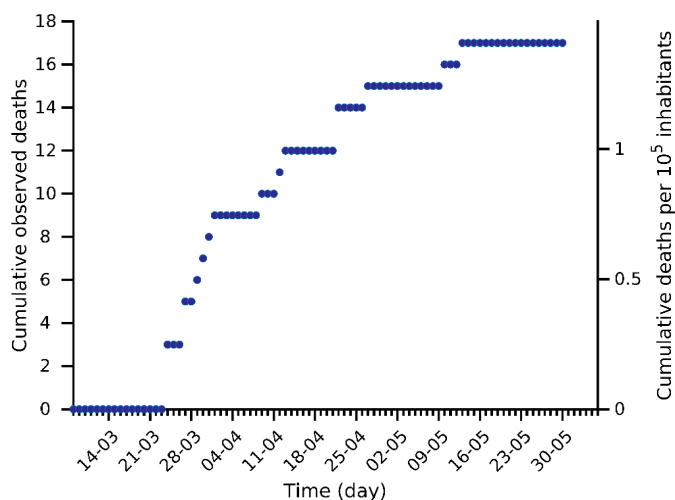
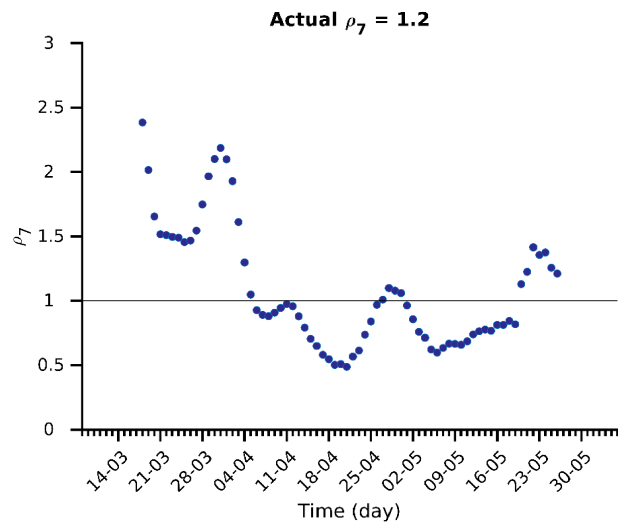
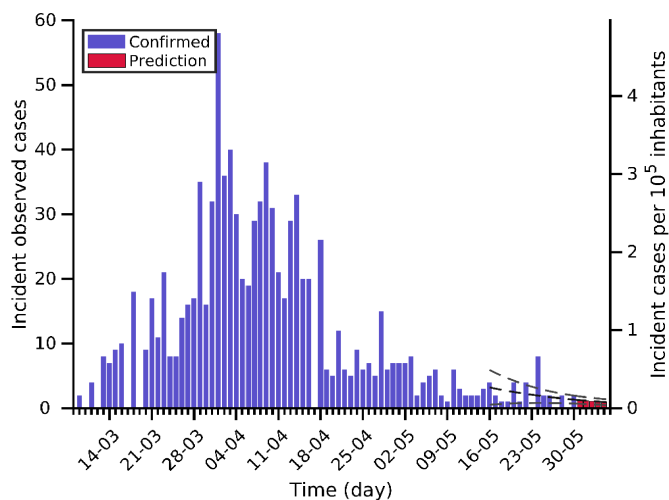
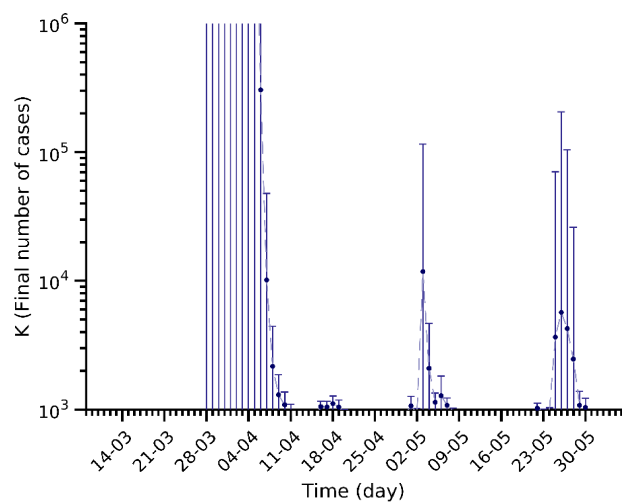
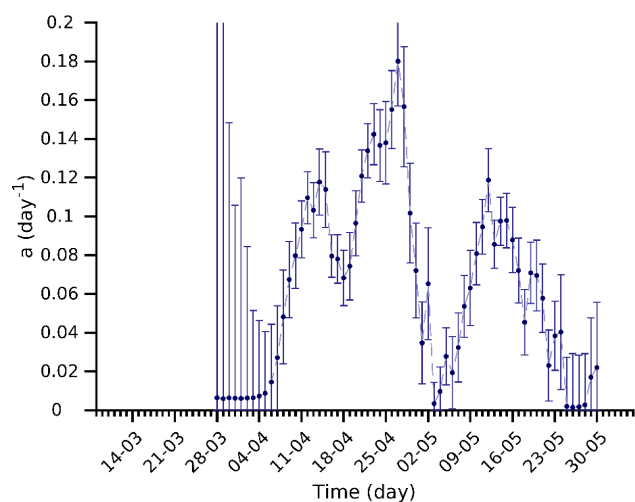
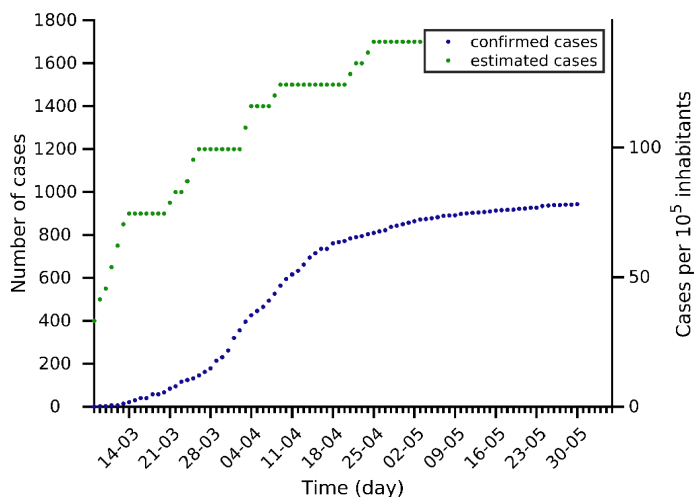
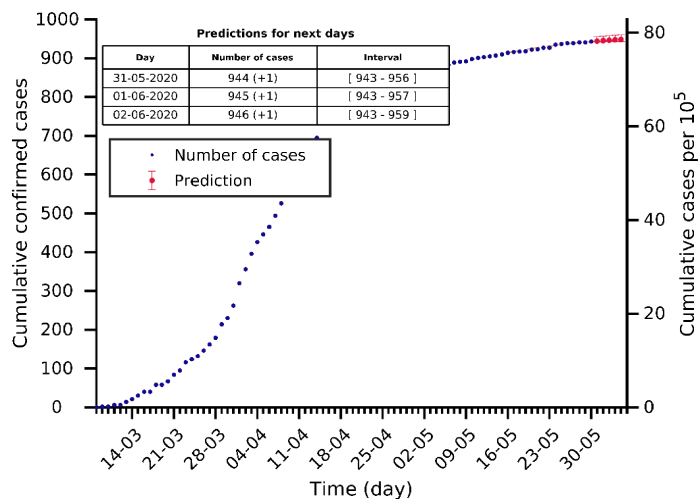
# Slovenia 30-05-2020. Population: 2.1M. Current cumulated incidence: 71/10<sup>5</sup>



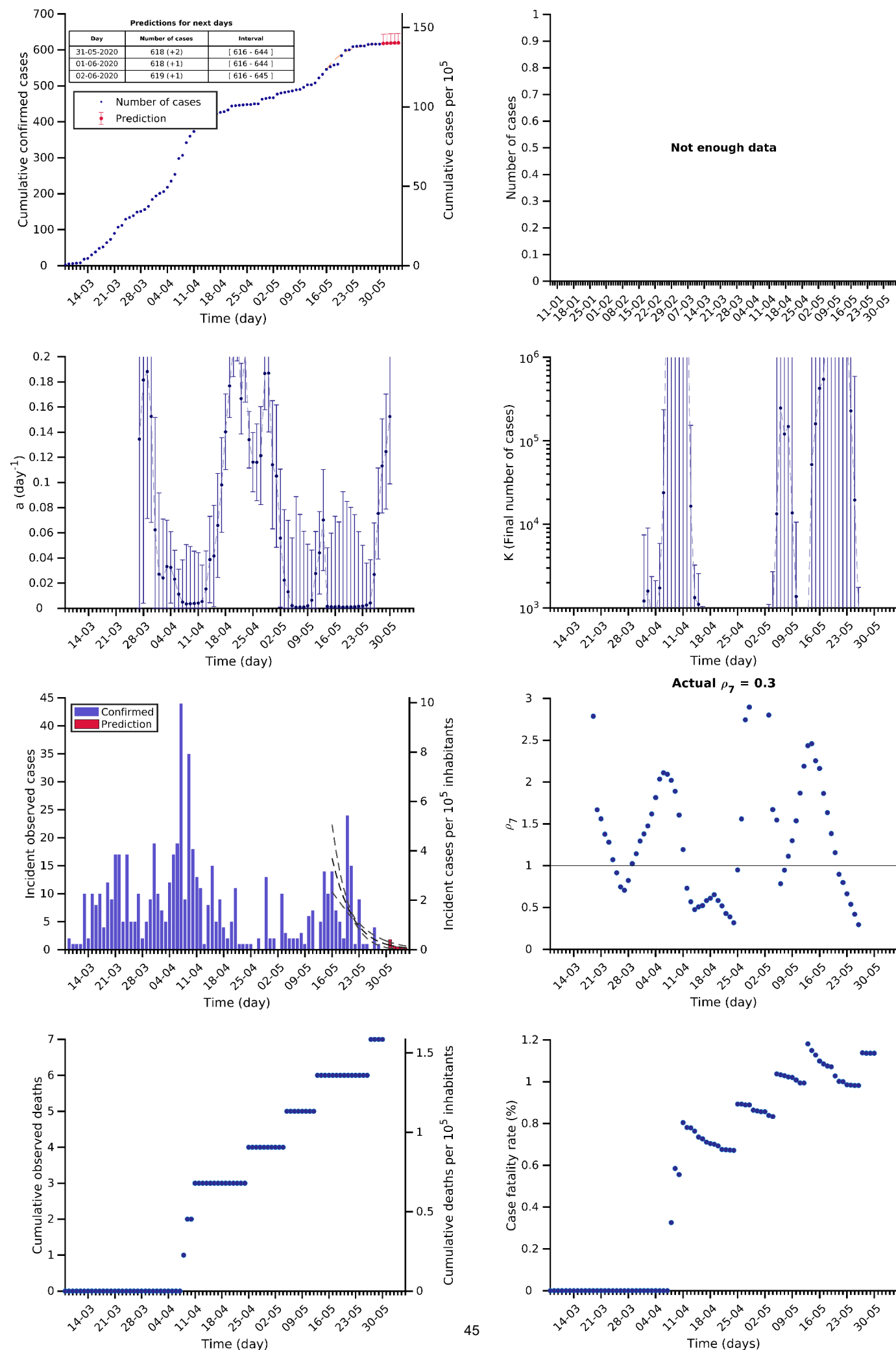
# Latvia 30-05-2020. Population: 1.9M. Current cumulated incidence: 56/10<sup>5</sup>



# Cyprus 30-05-2020. Population: 1.2M. Current cumulated incidence: 78/10<sup>5</sup>



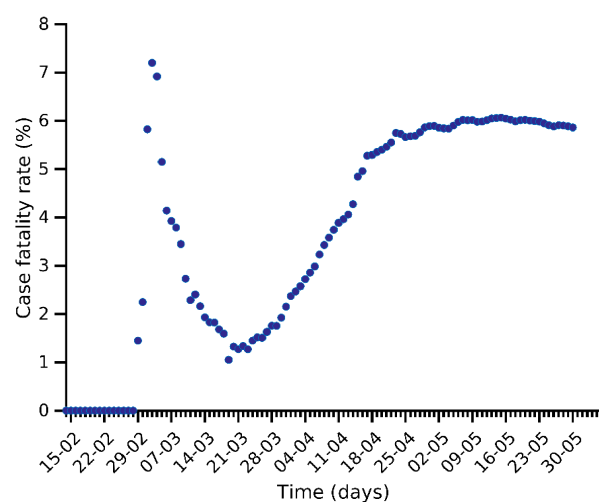
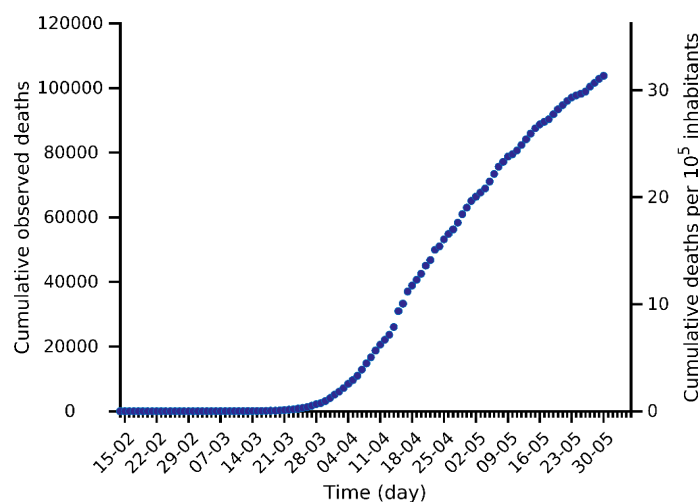
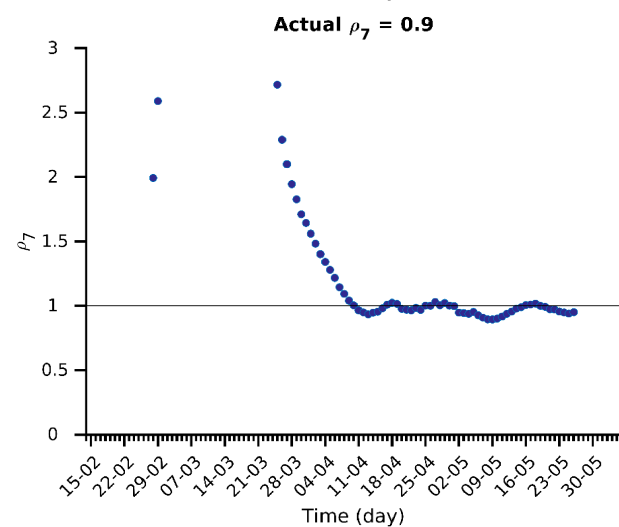
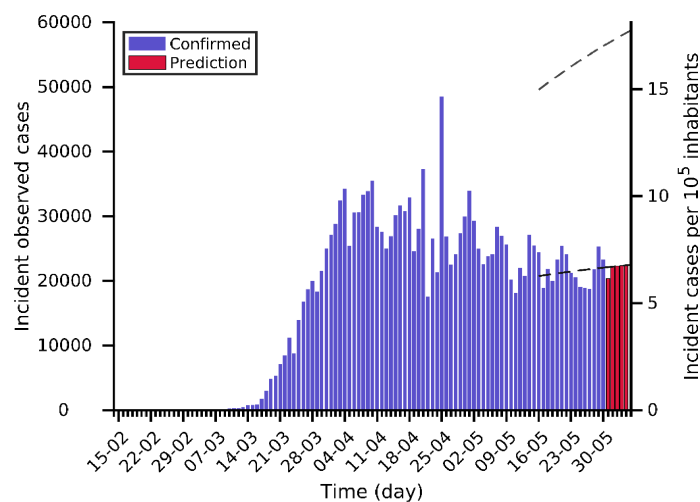
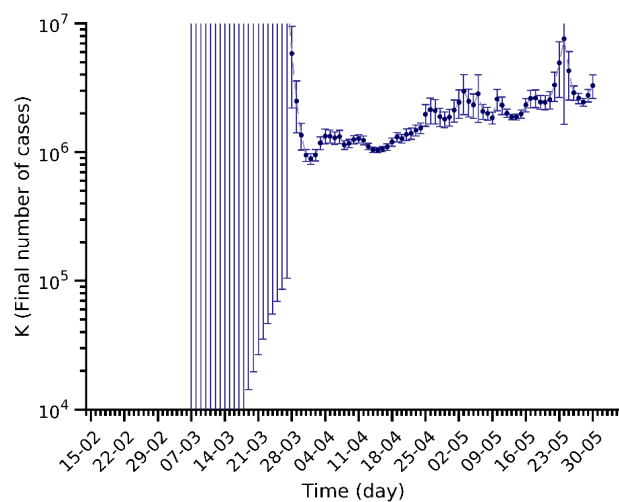
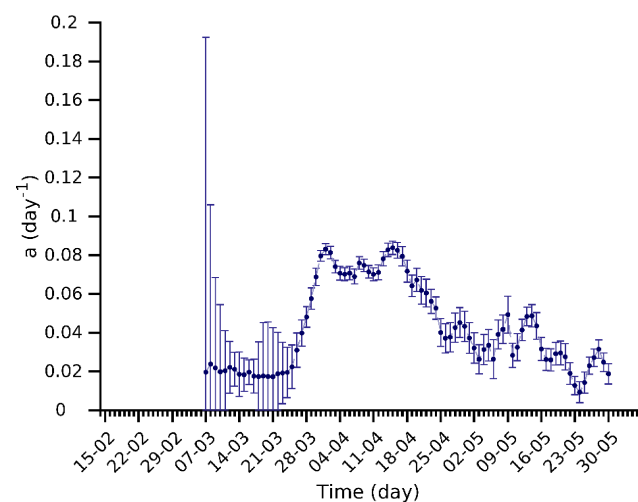
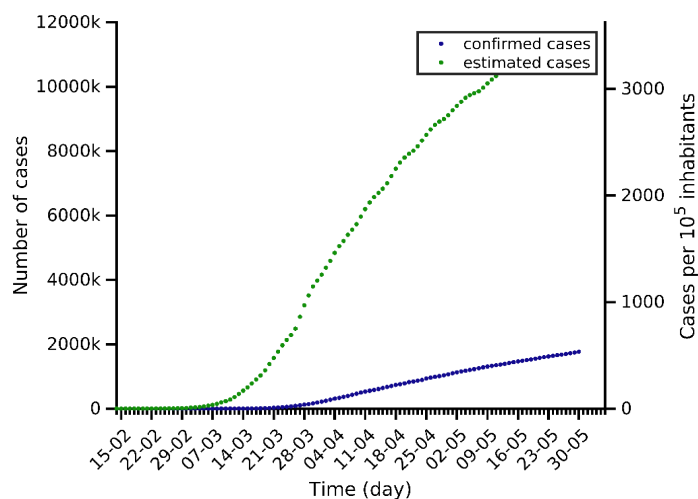
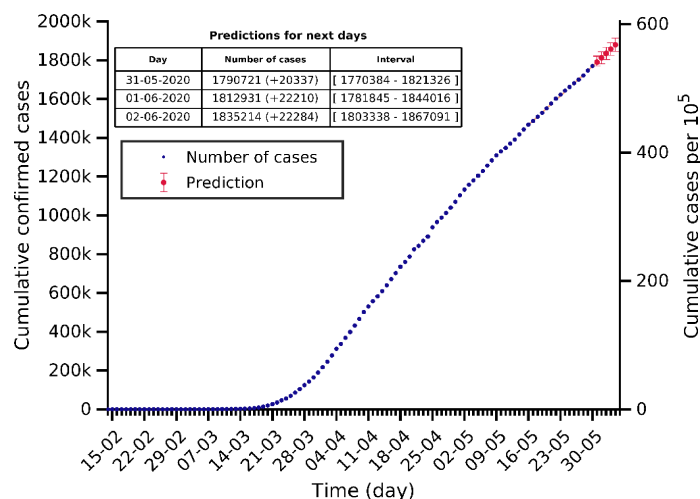
# Malta 30-05-2020. Population: 0.4M. Current cumulated incidence: 140/10<sup>5</sup>



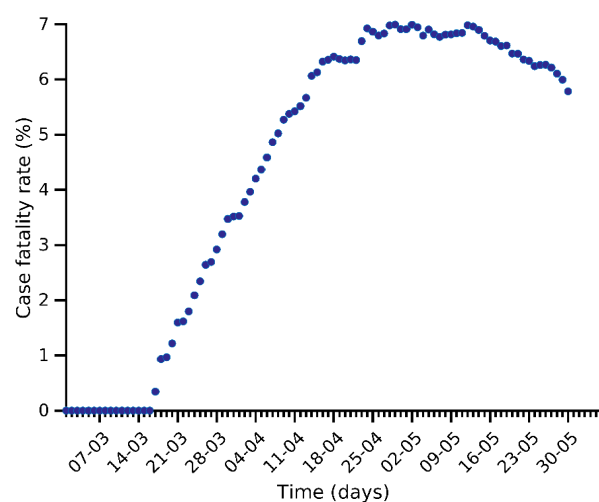
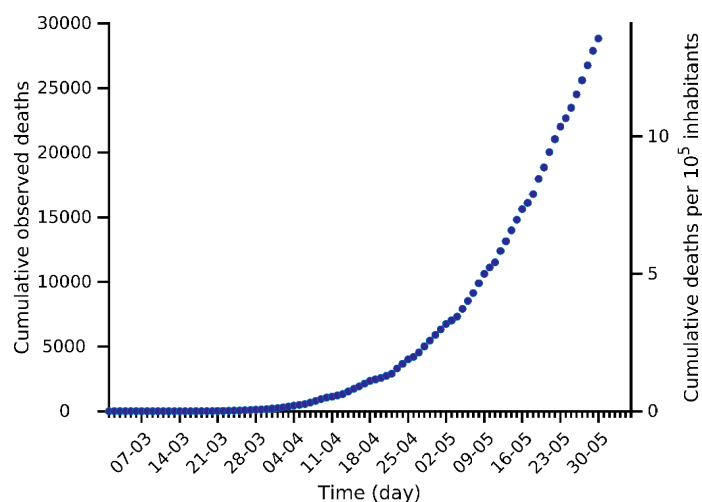
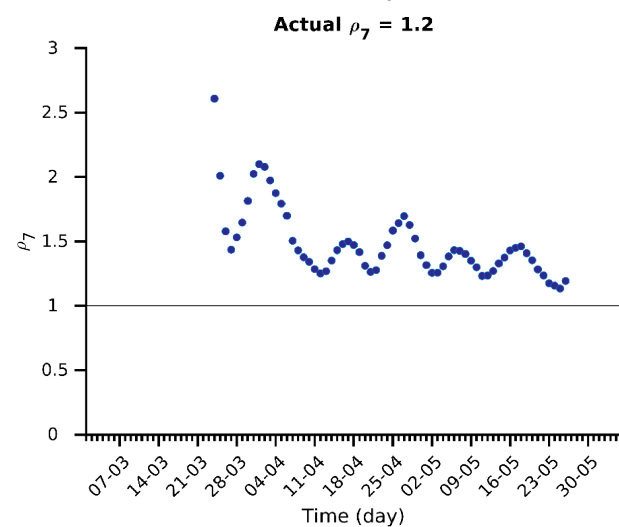
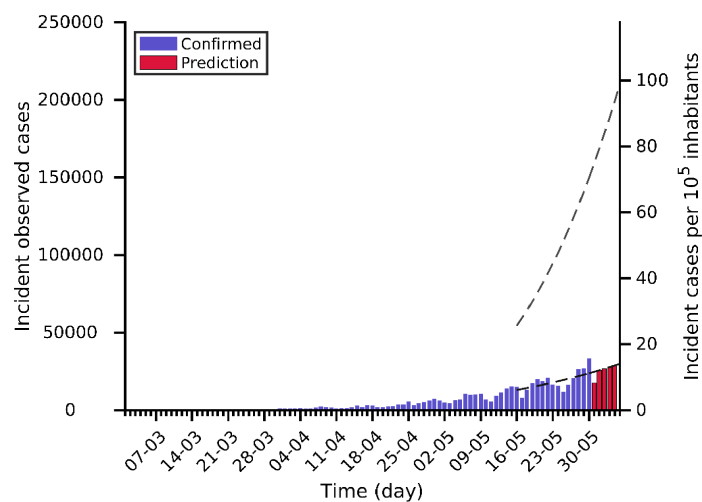
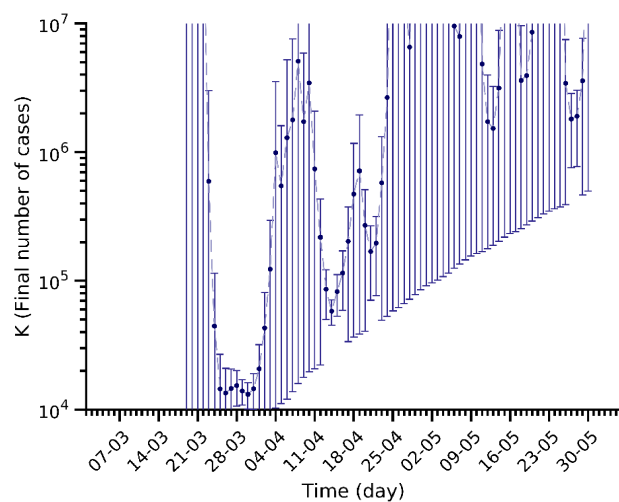
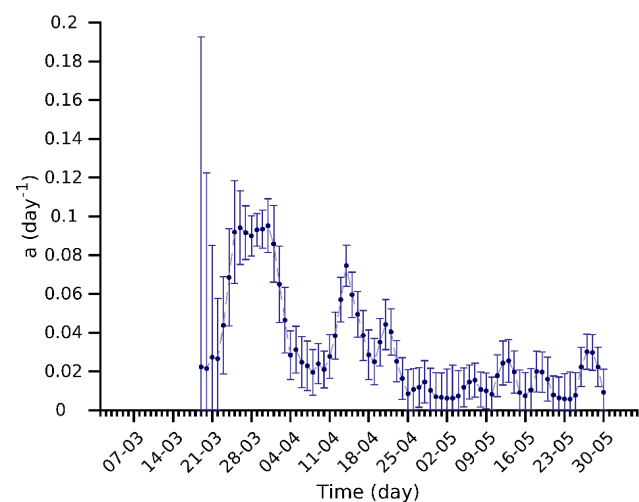
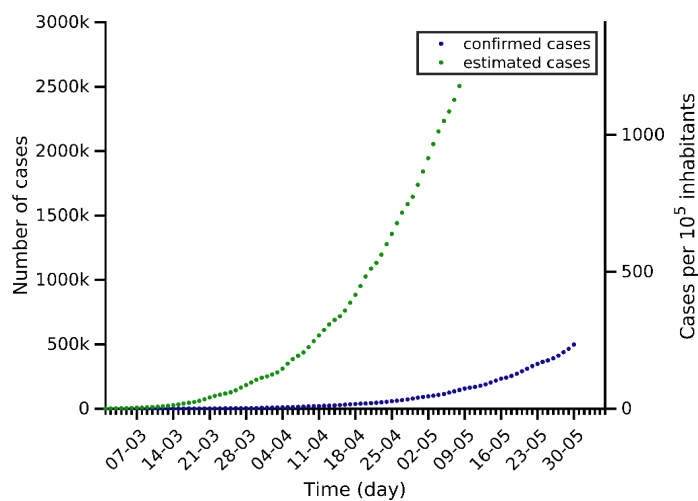
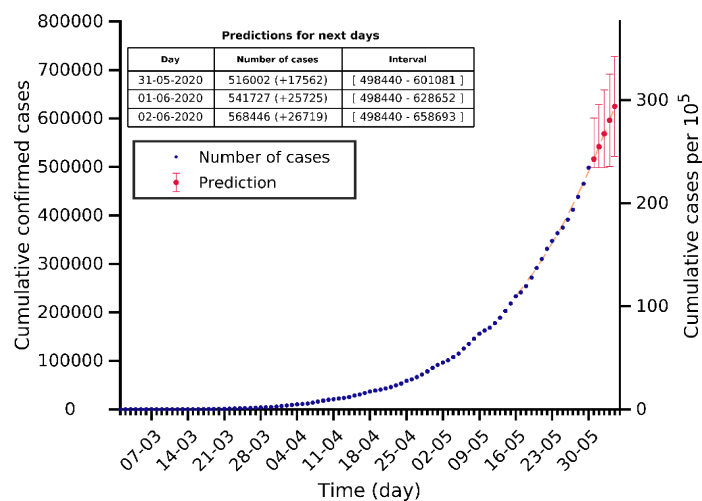
## **(2) Analysis and prediction of COVID-19 for other countries**

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

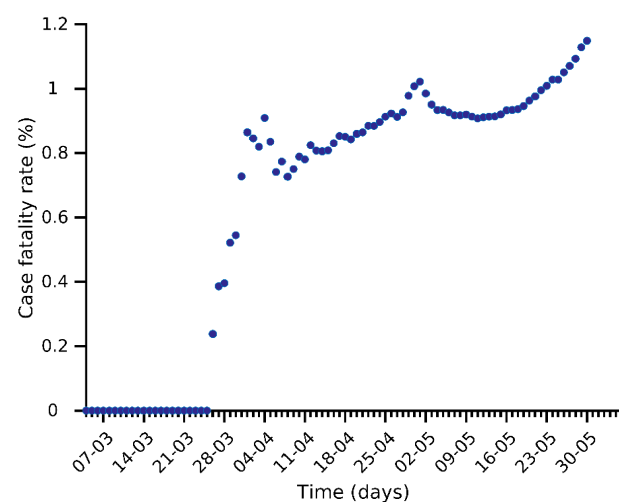
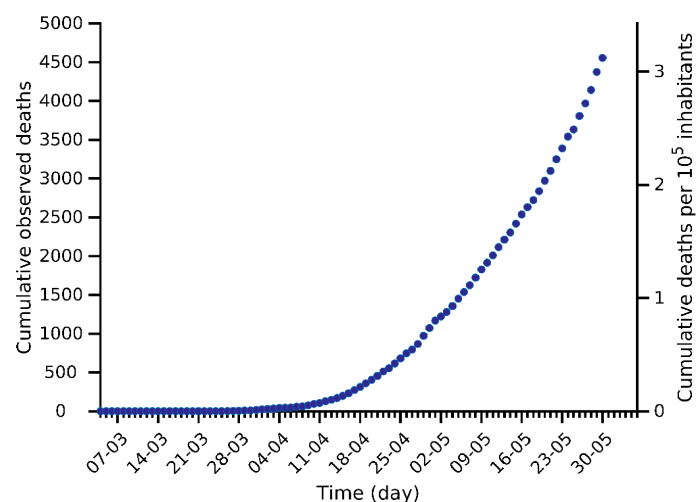
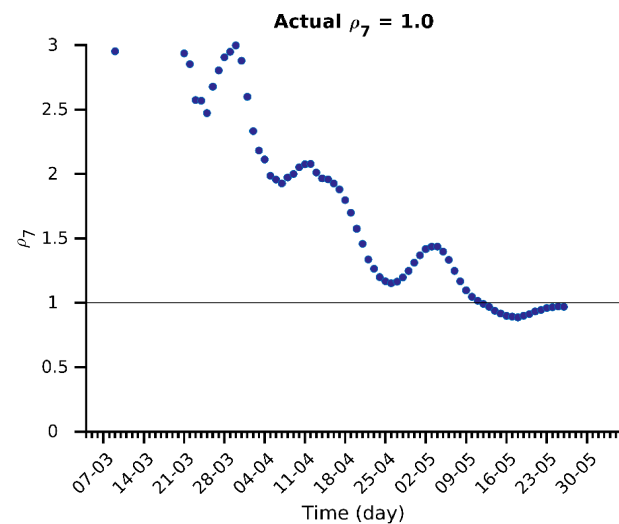
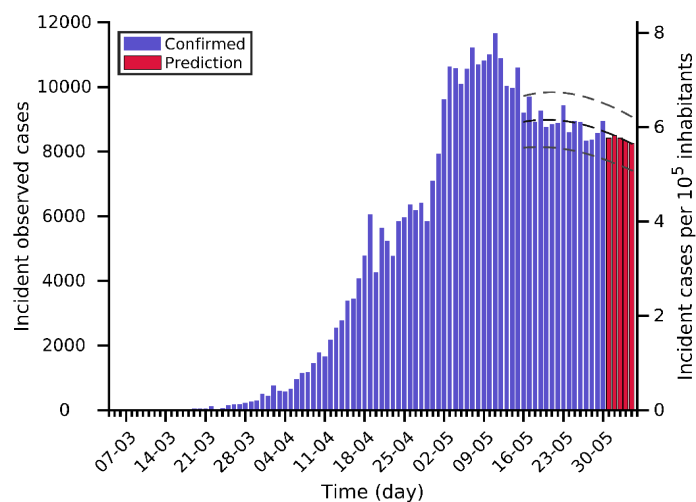
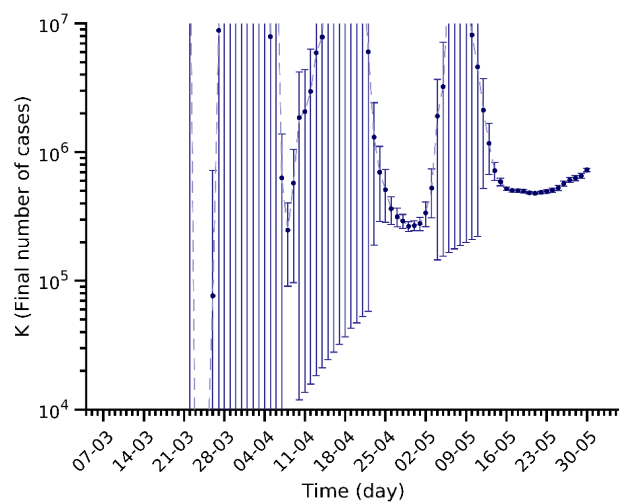
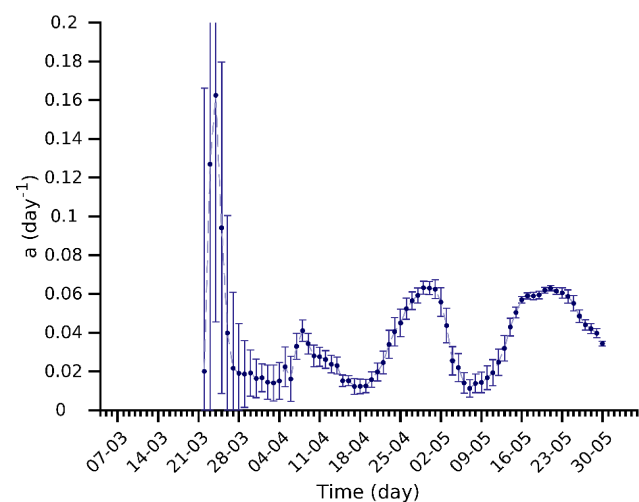
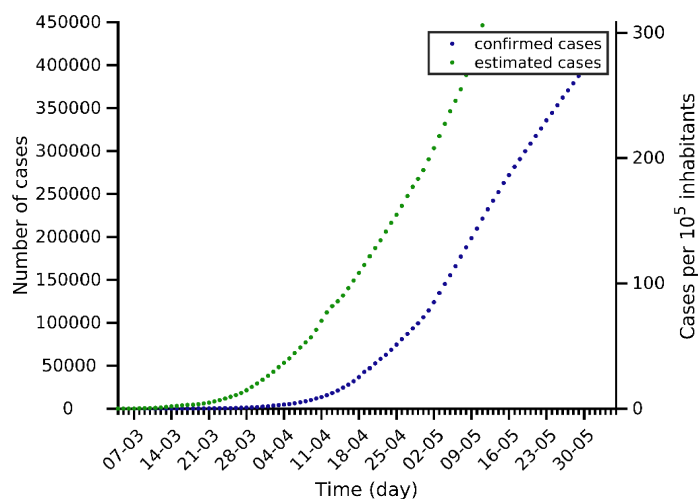
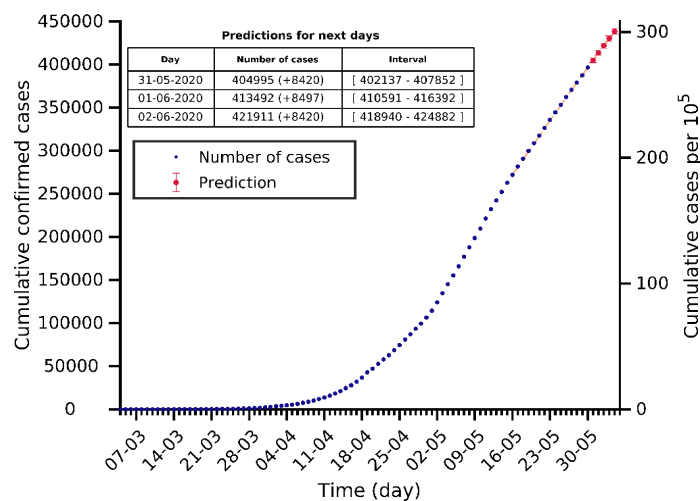
# USA 30-05-2020. Population: 331.0M. Current cumulated incidence: 535/10<sup>5</sup>



# Brazil 30-05-2020. Population: 212.6M. Current cumulated incidence: 234/10<sup>5</sup>

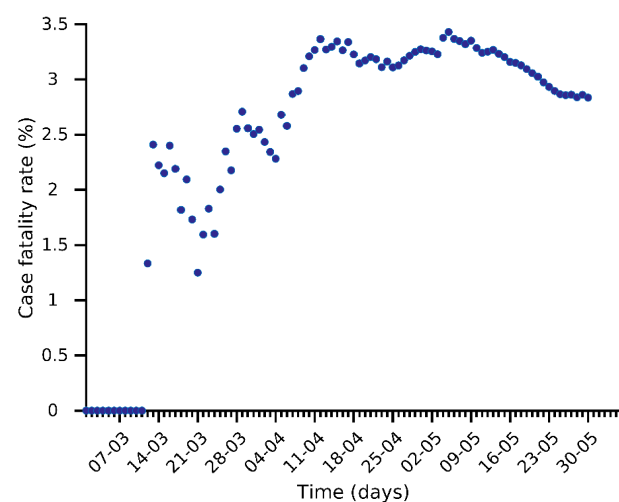
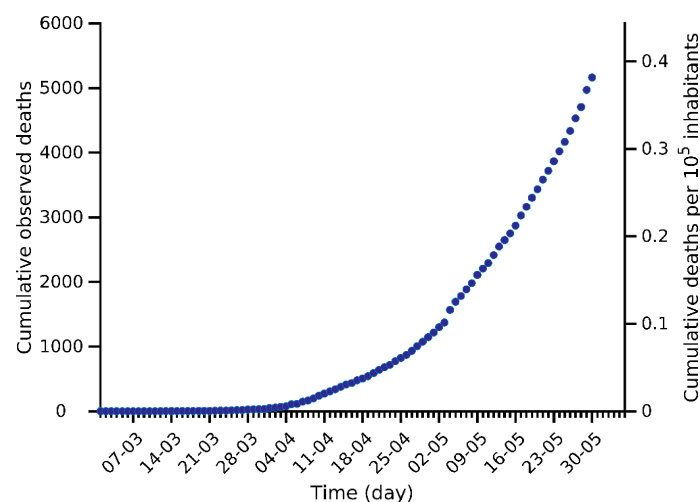
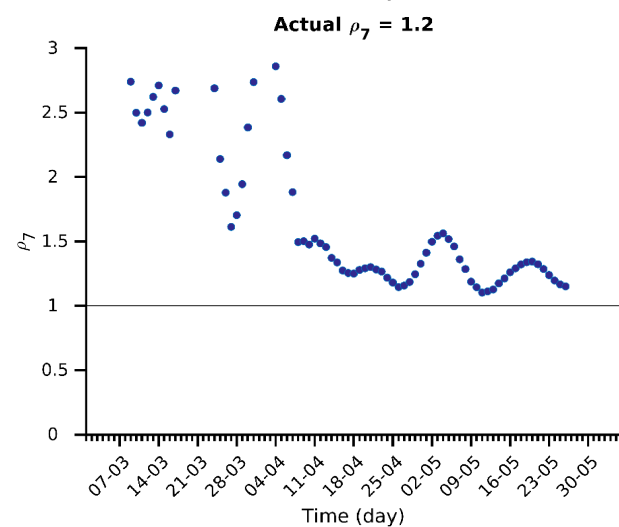
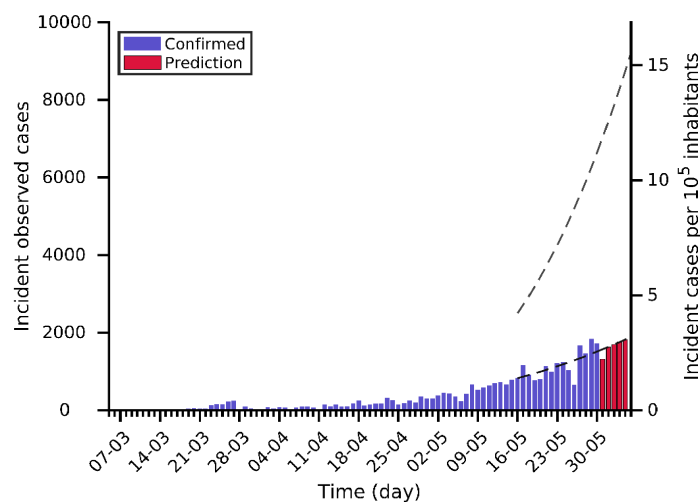
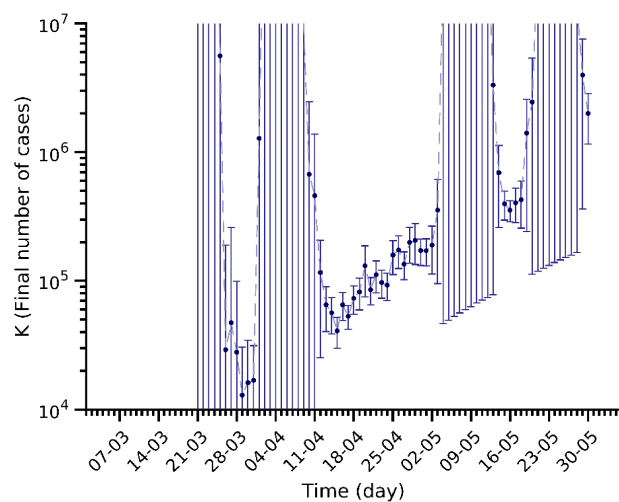
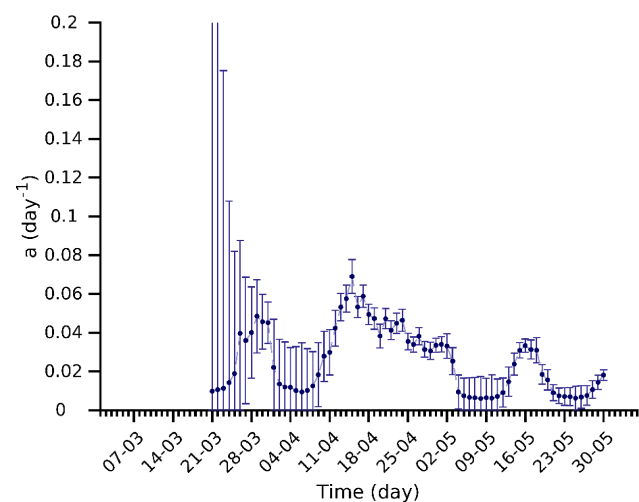
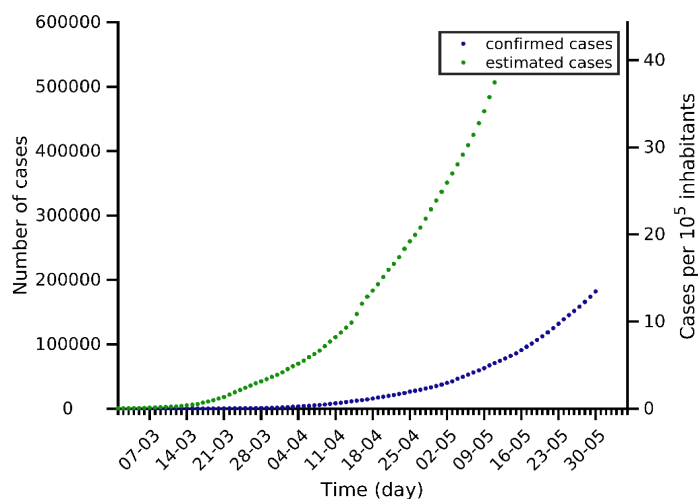
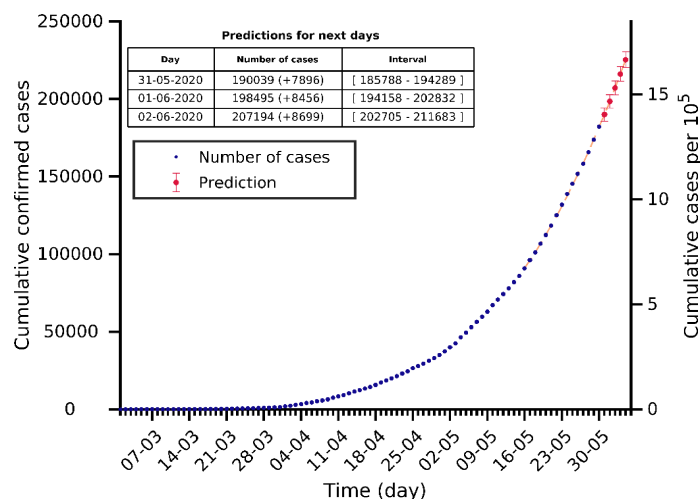


# Russia 30-05-2020. Population: 145.9M. Current cumulated incidence: 272/10<sup>5</sup>

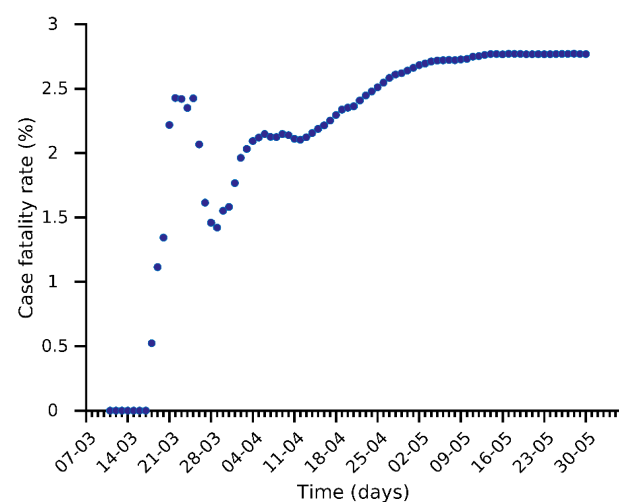
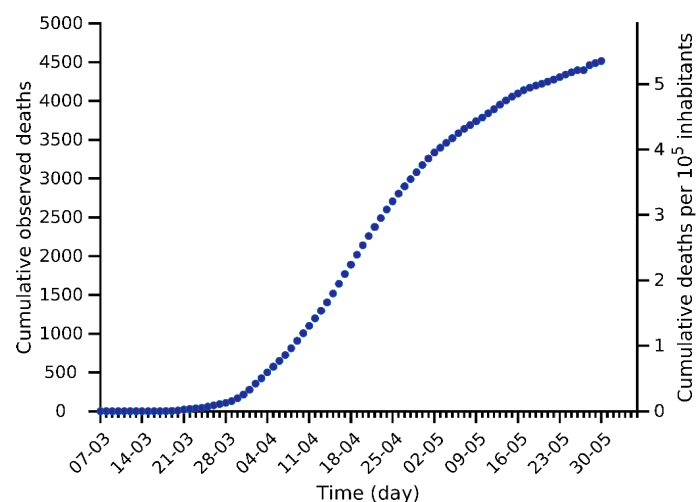
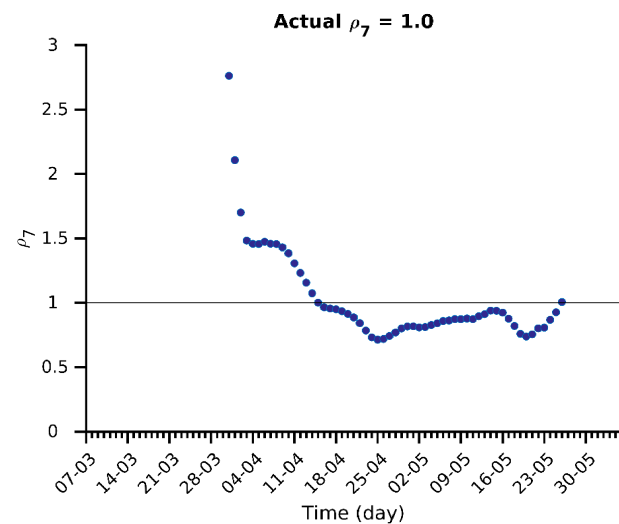
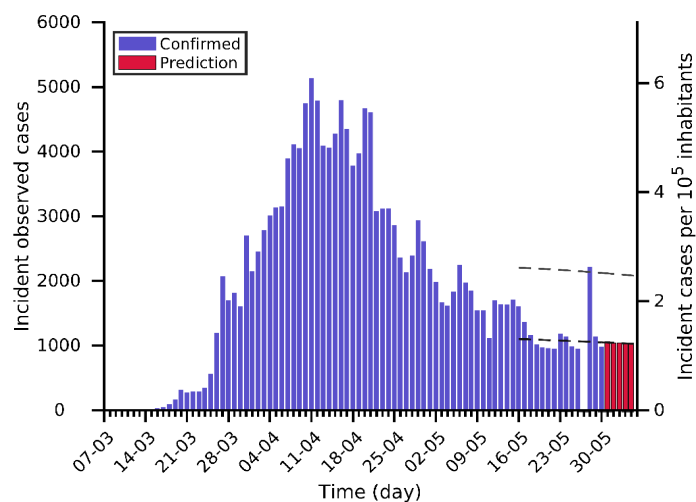
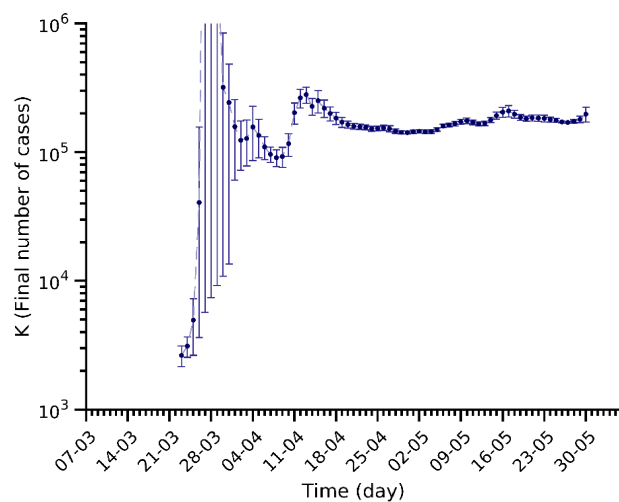
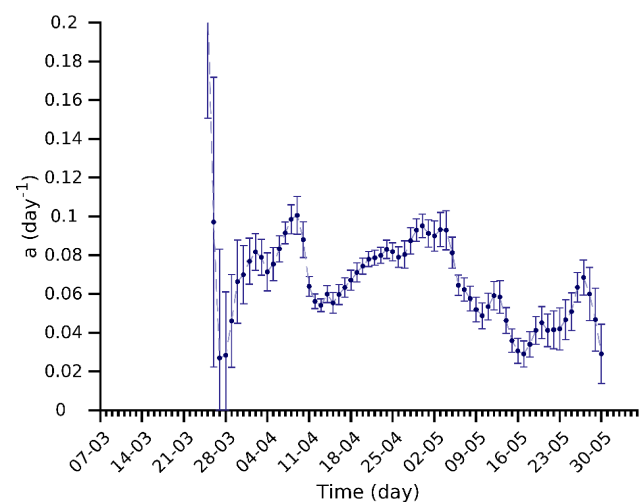
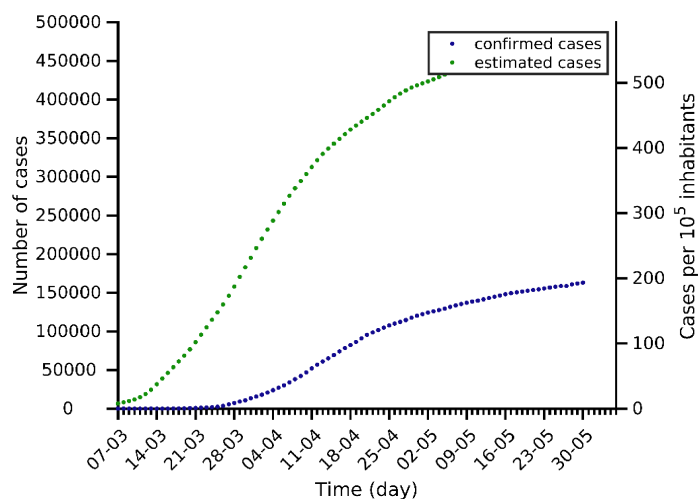
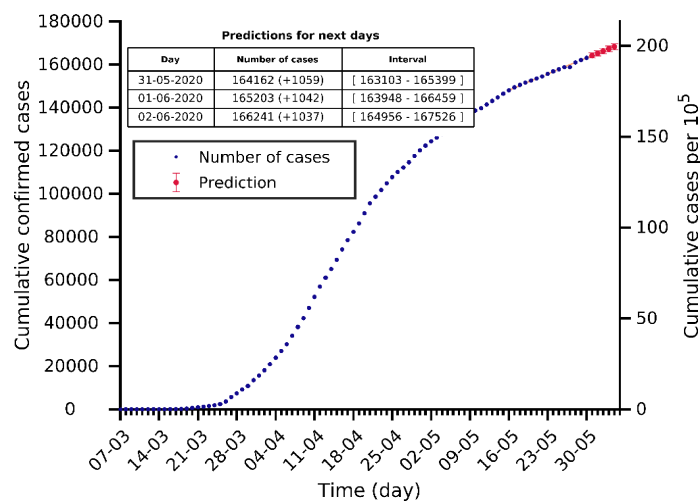




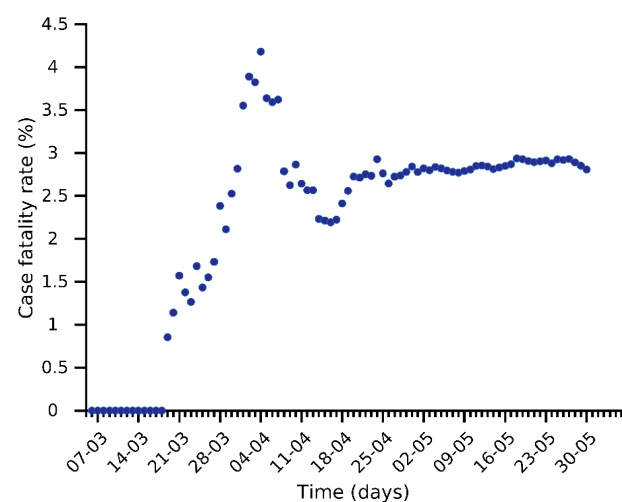
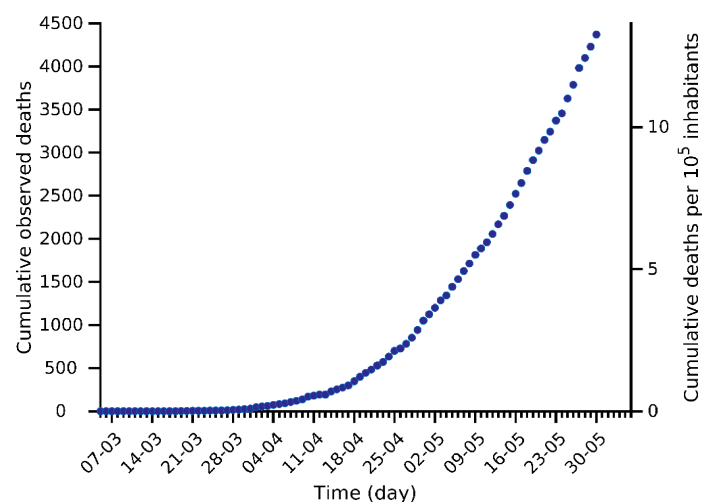
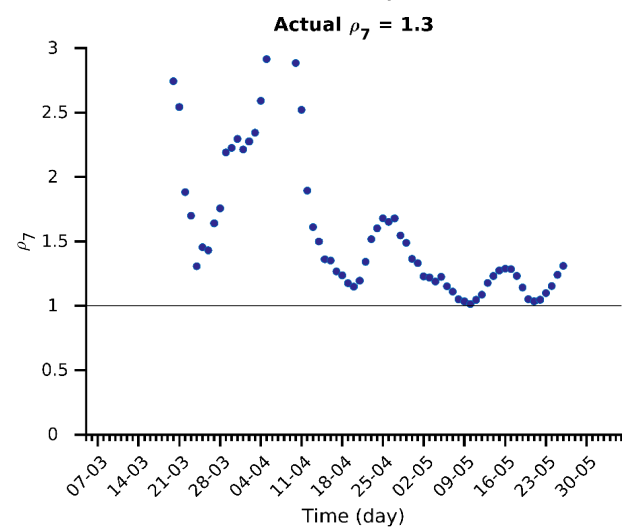
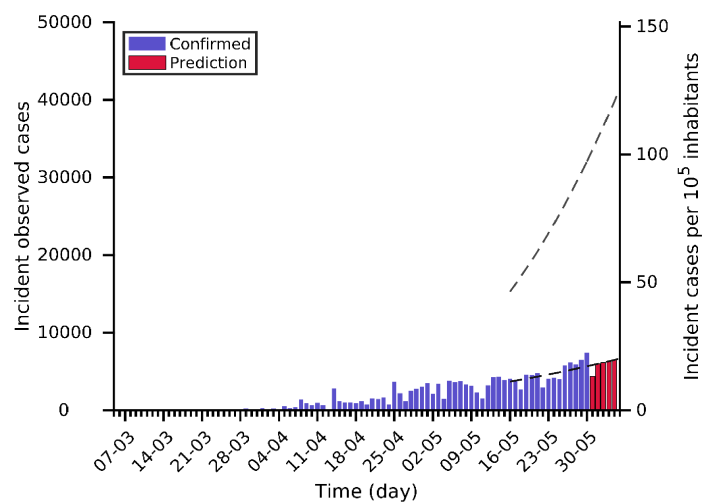
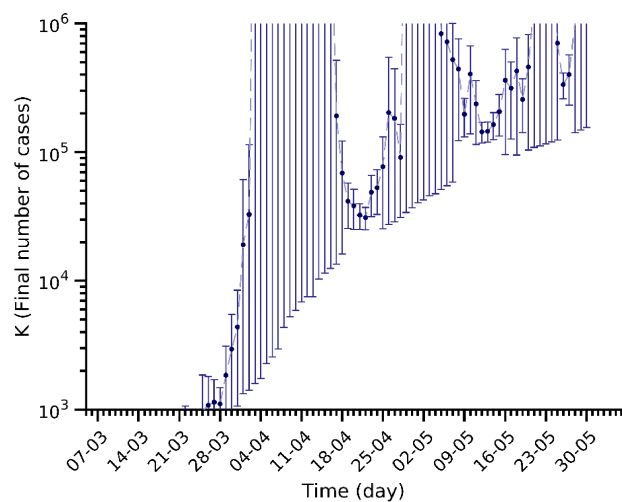
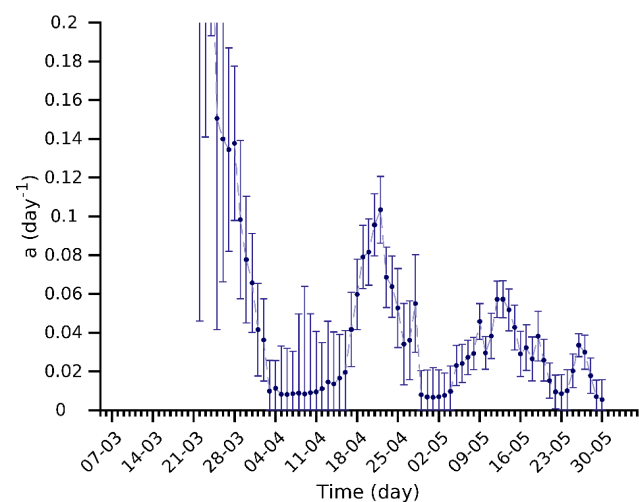
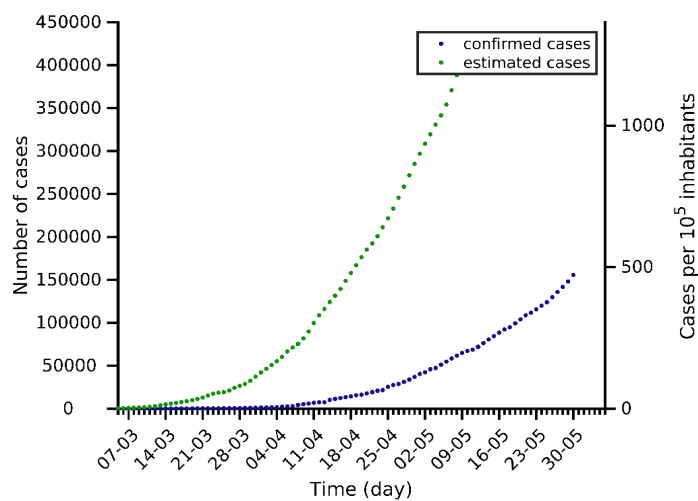
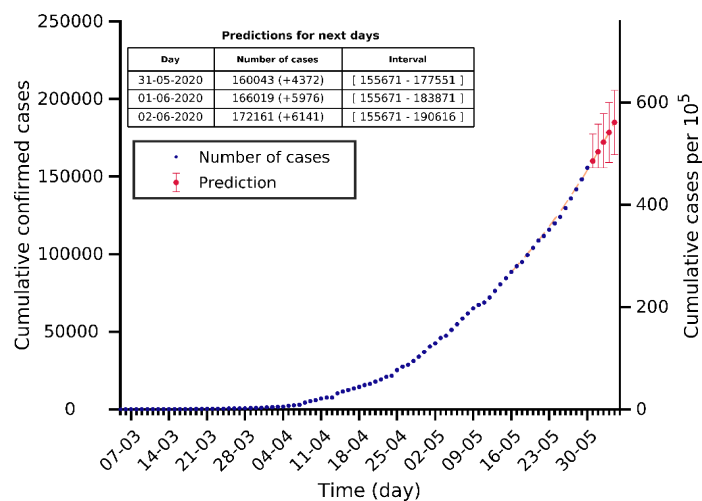
# India 30-05-2020. Population: 1353.0M. Current cumulated incidence: 13/10<sup>5</sup>



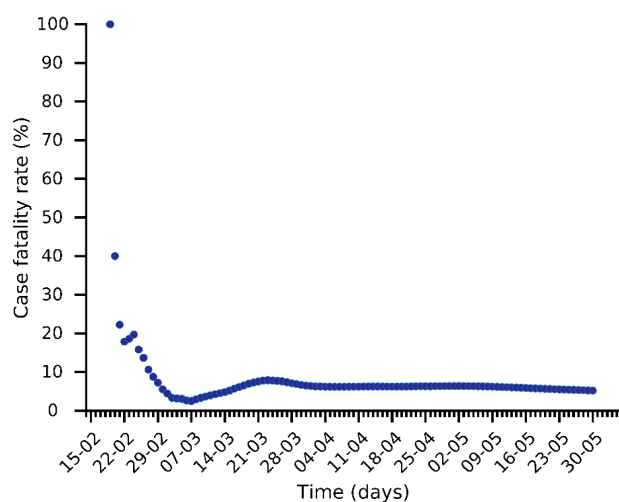
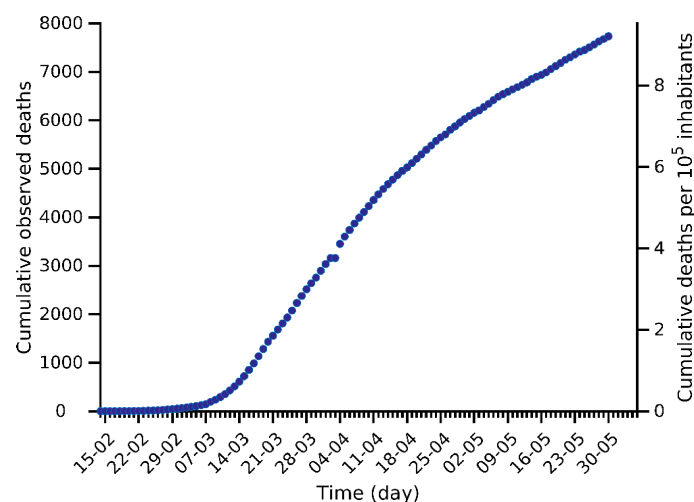
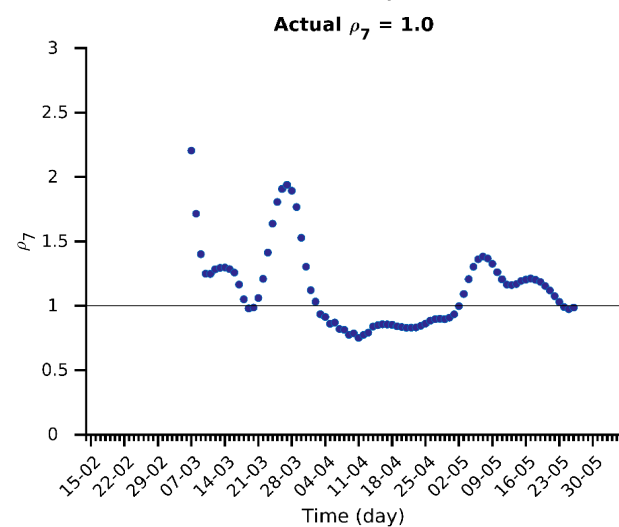
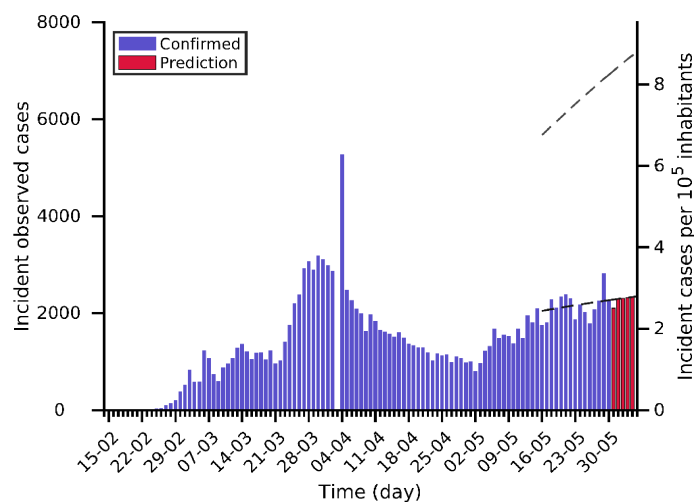
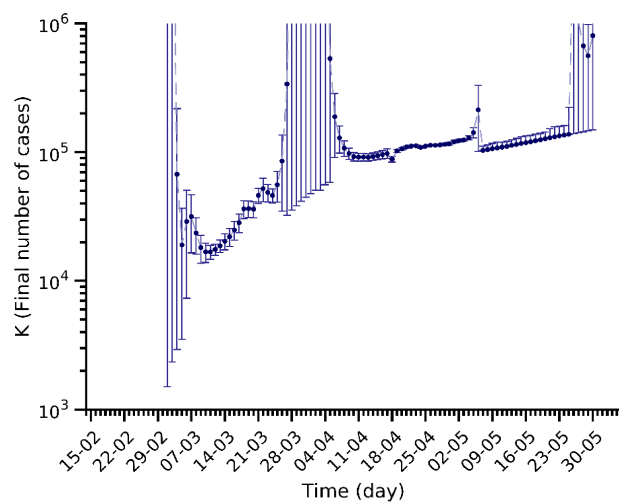
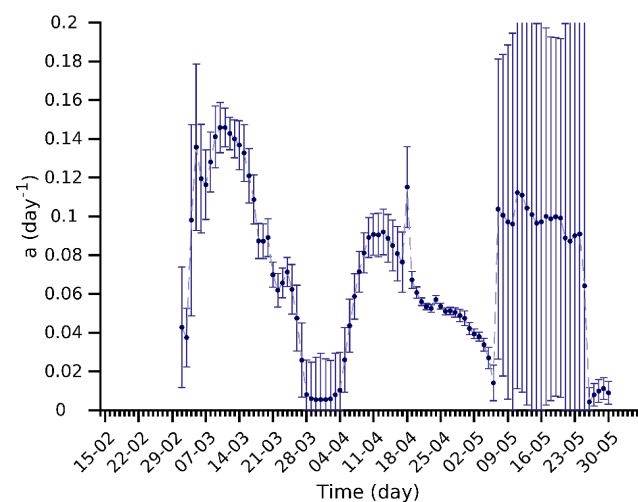
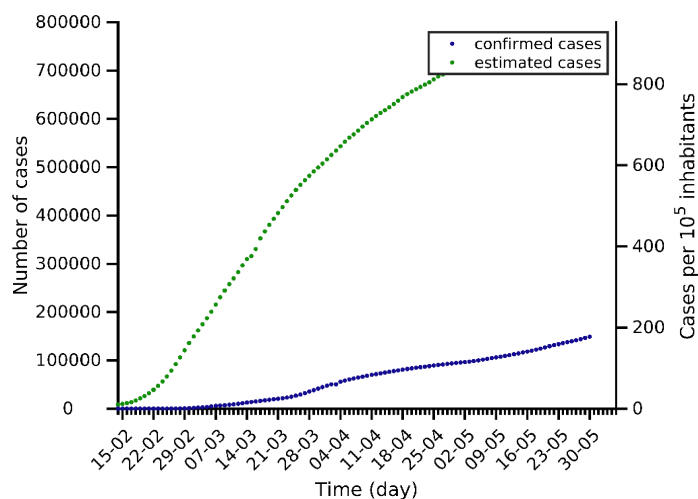
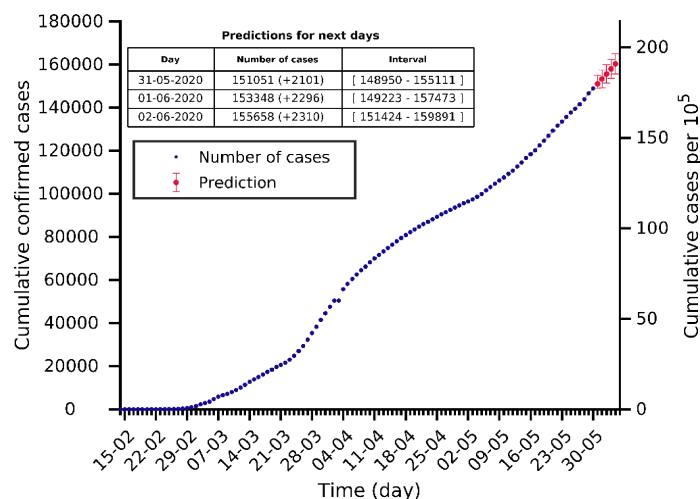
# Turkey 30-05-2020. Population: 84.3M. Current cumulated incidence: 193/10<sup>5</sup>



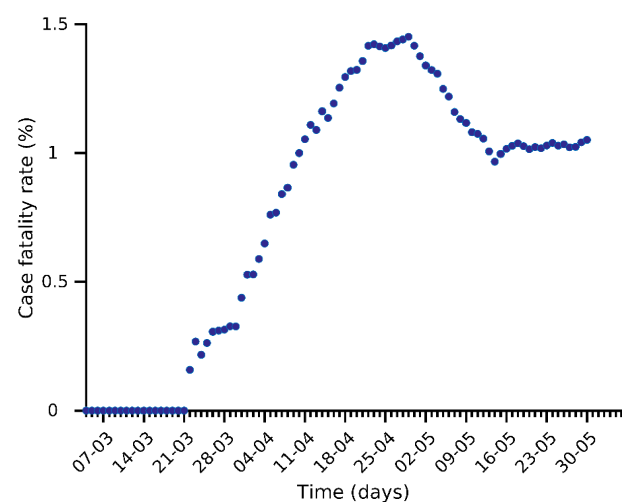
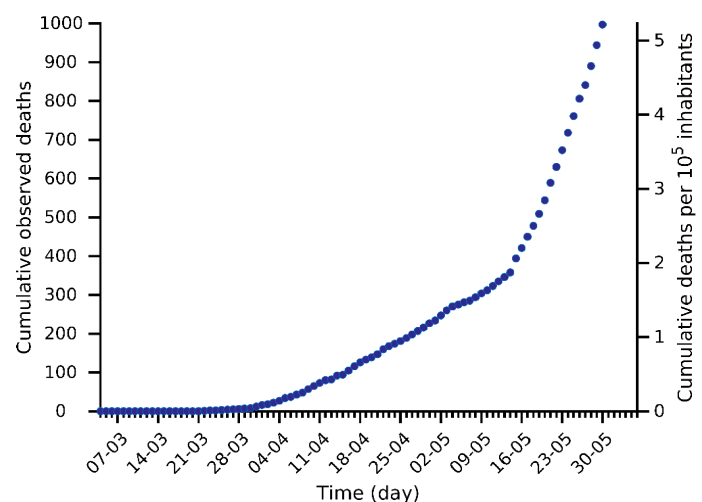
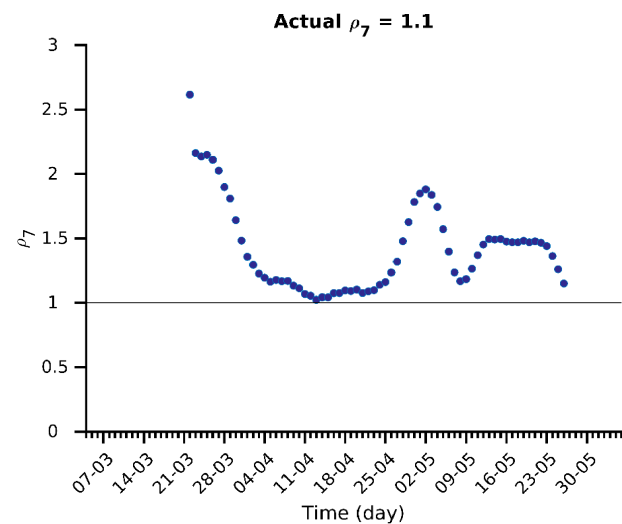
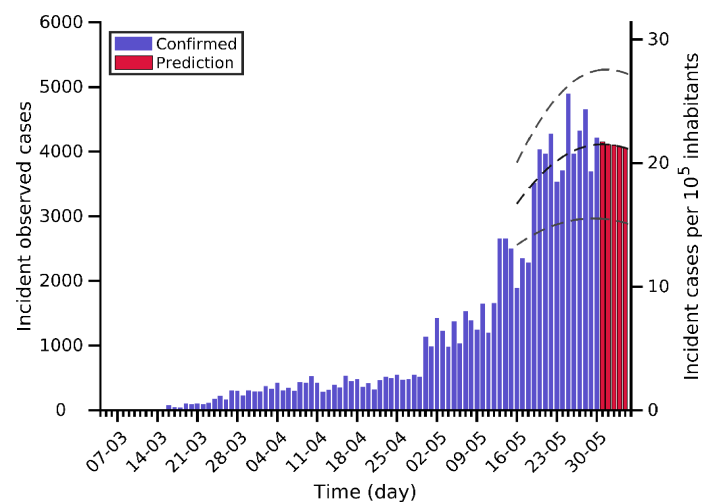
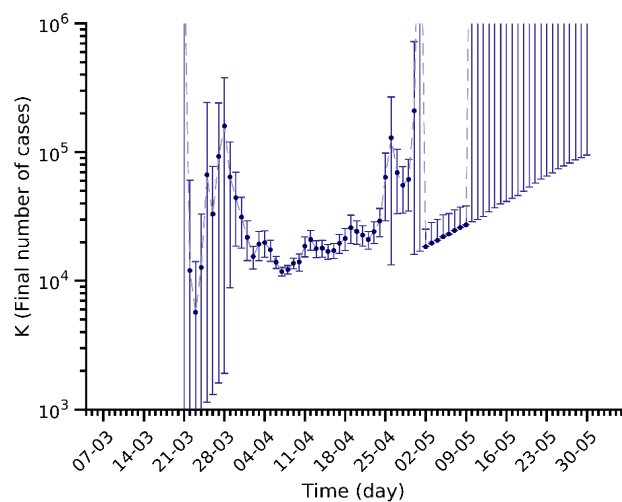
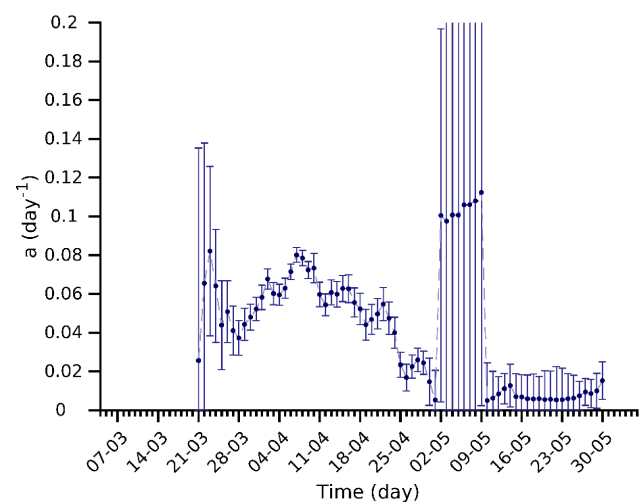
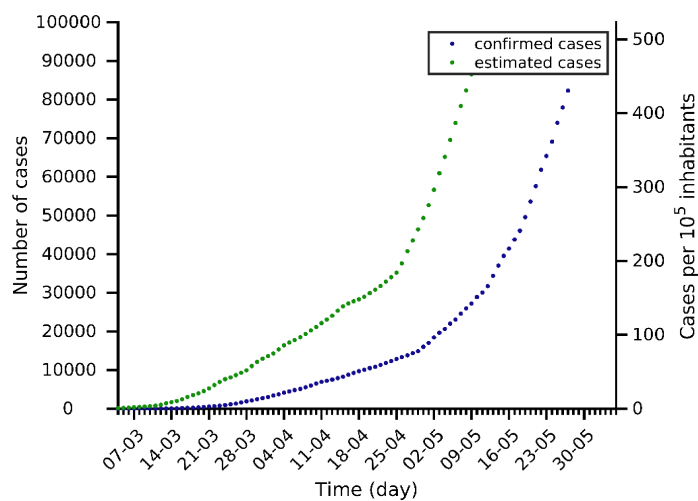
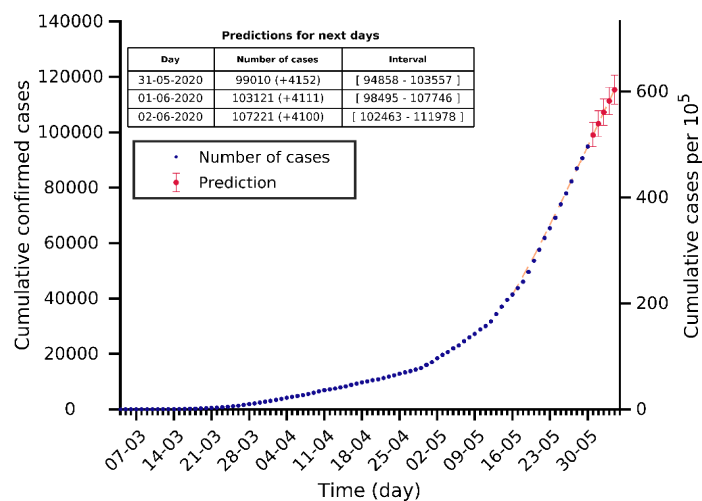
# Peru 30-05-2020. Population: 33.0M. Current cumulated incidence: 472/10<sup>5</sup>



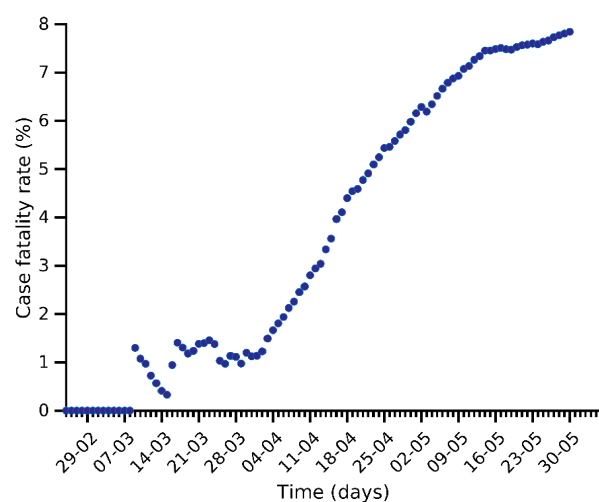
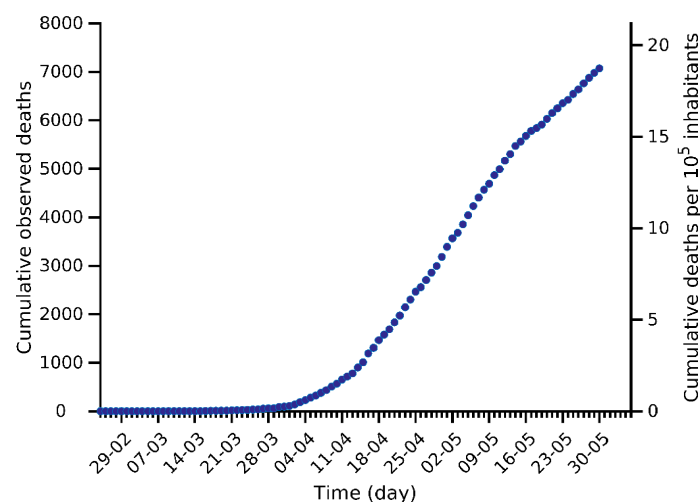
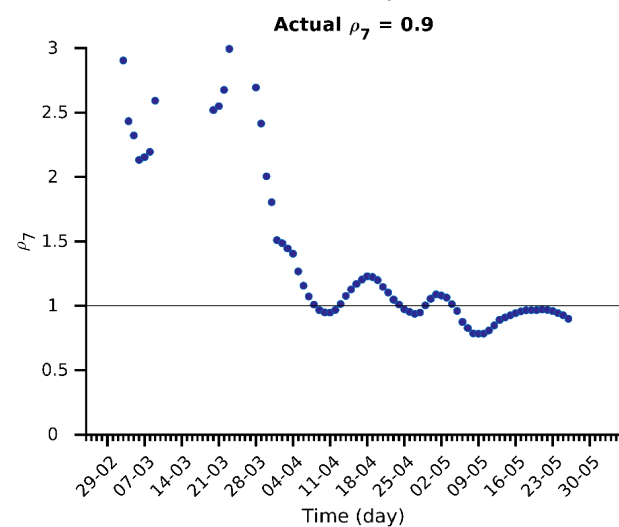
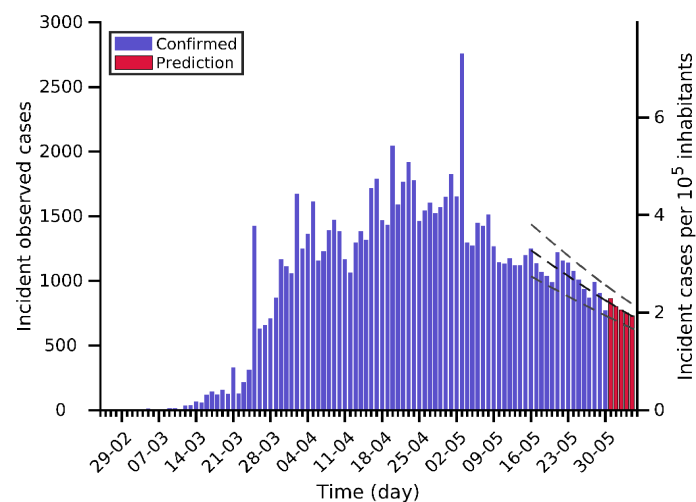
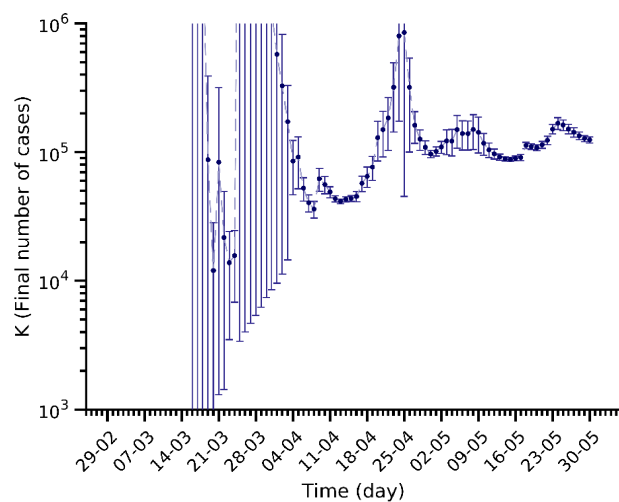
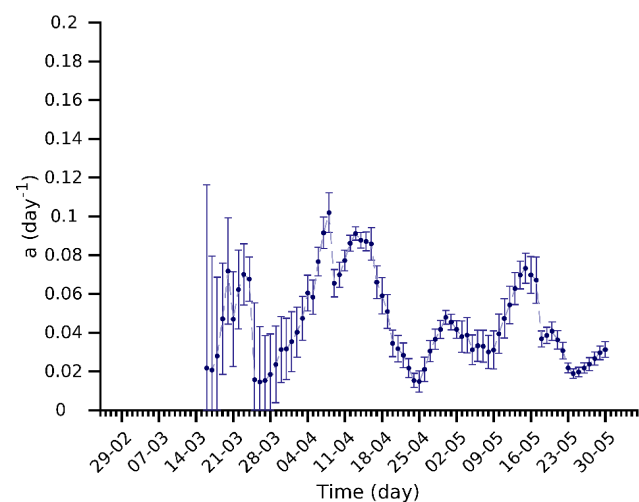
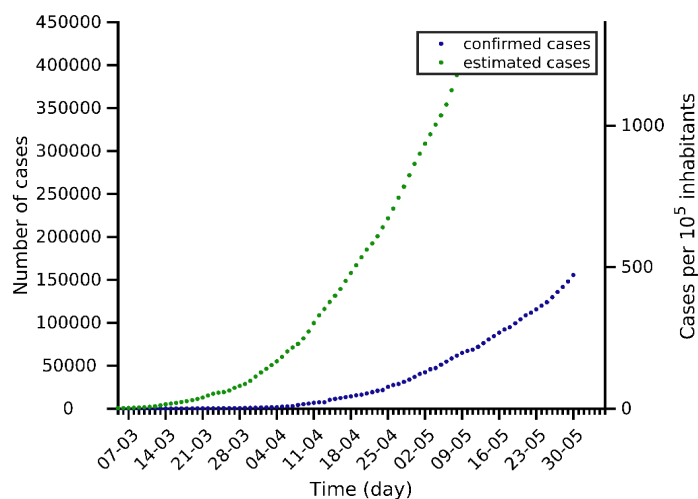
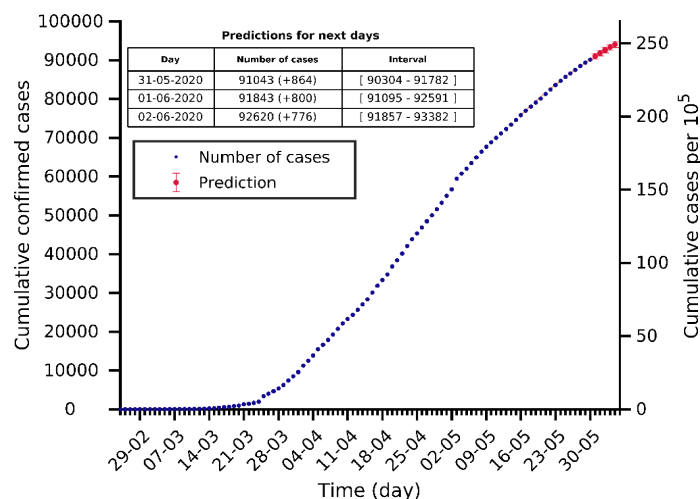
# Iran 30-05-2020. Population: 84.0M. Current cumulated incidence: 177/10<sup>5</sup>



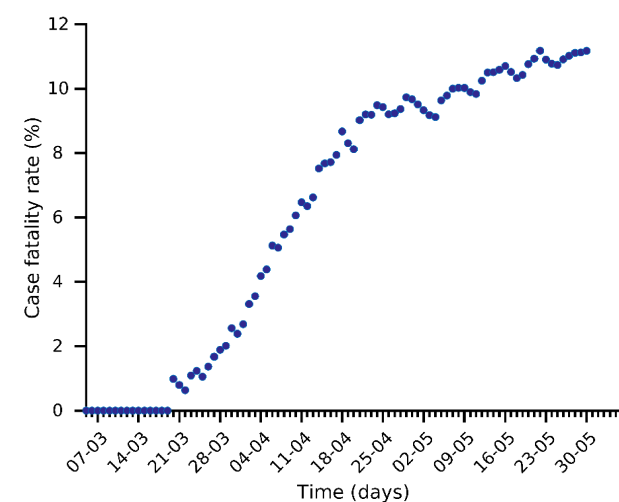
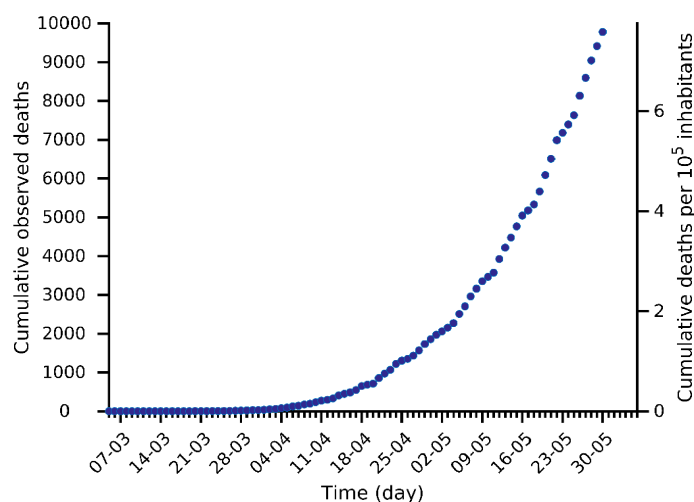
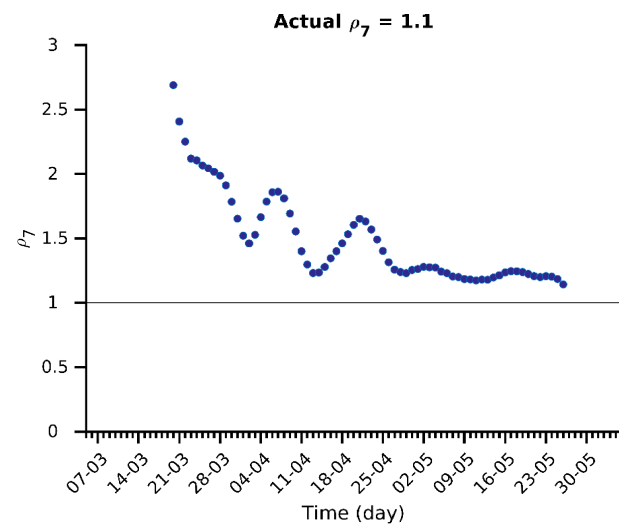
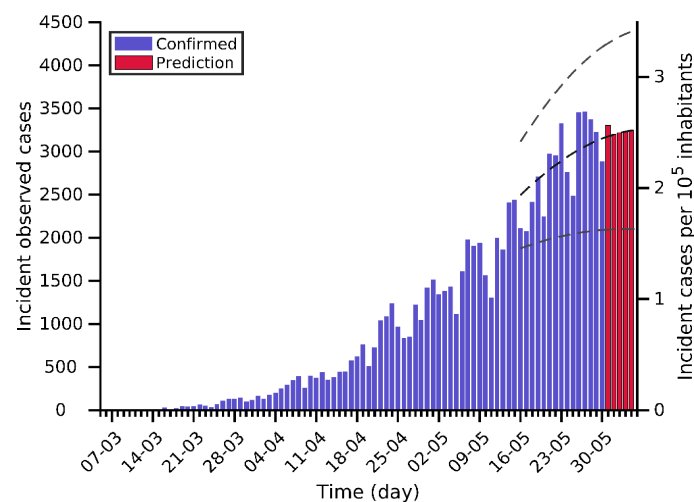
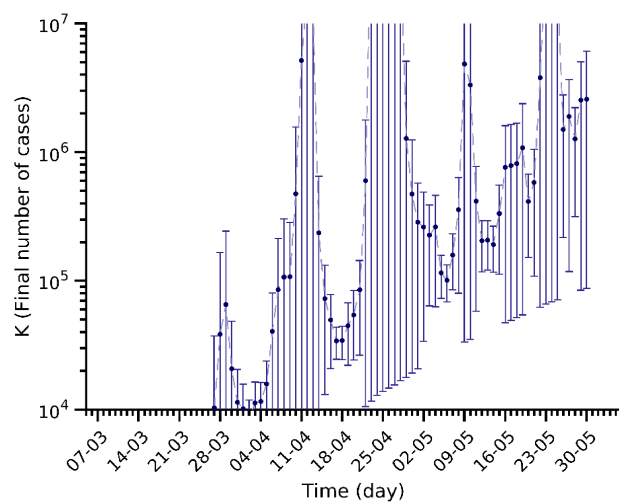
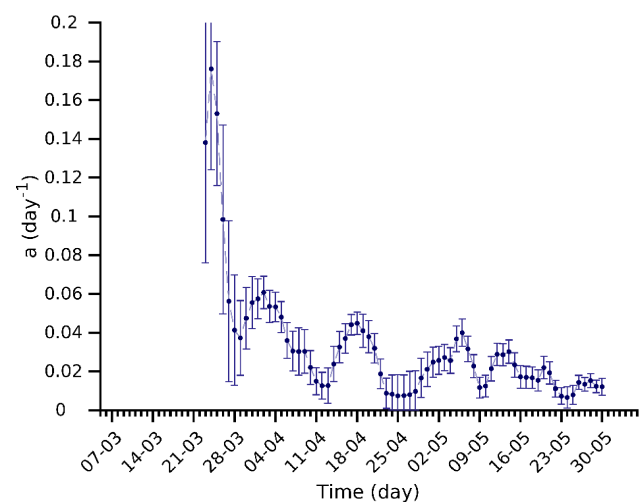
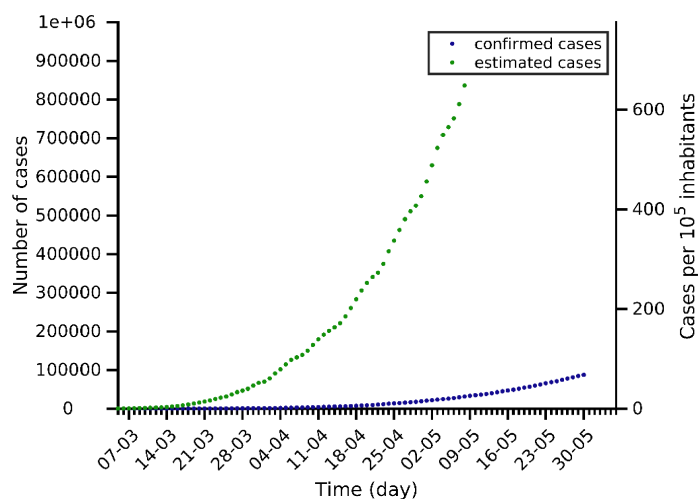
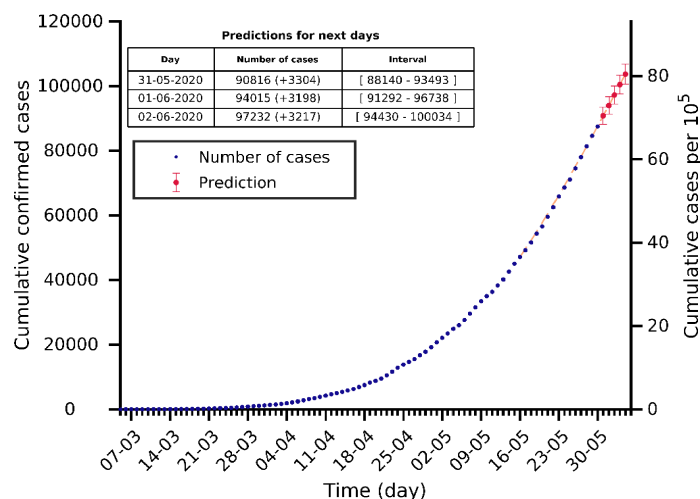
# Chile 30-05-2020. Population: 19.1M. Current cumulated incidence: 496/10<sup>5</sup>

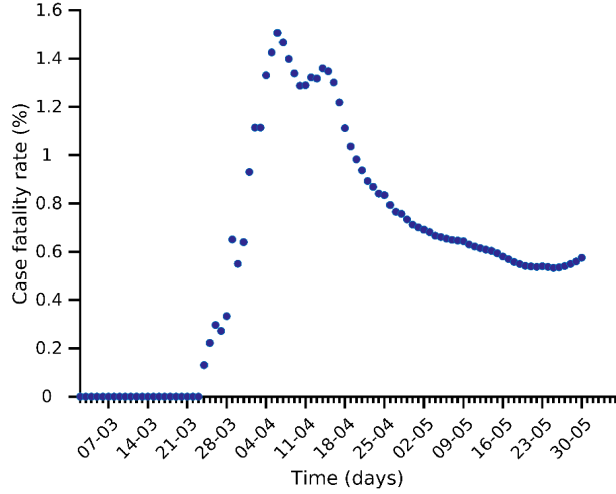
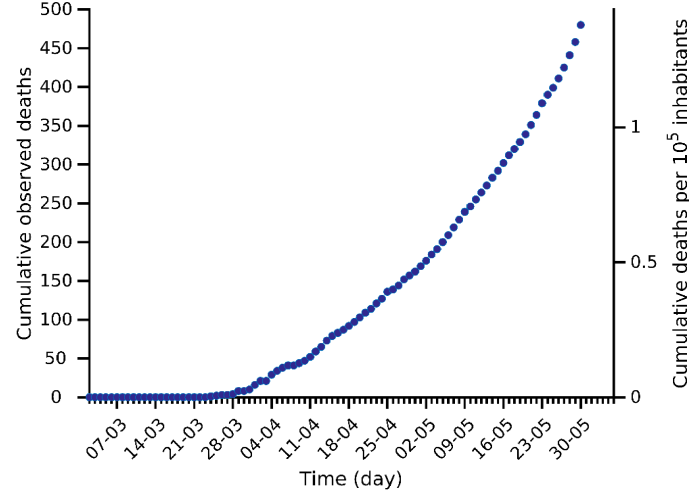
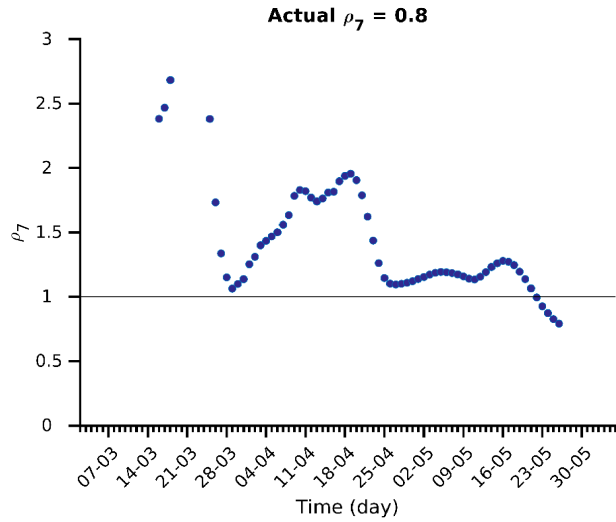
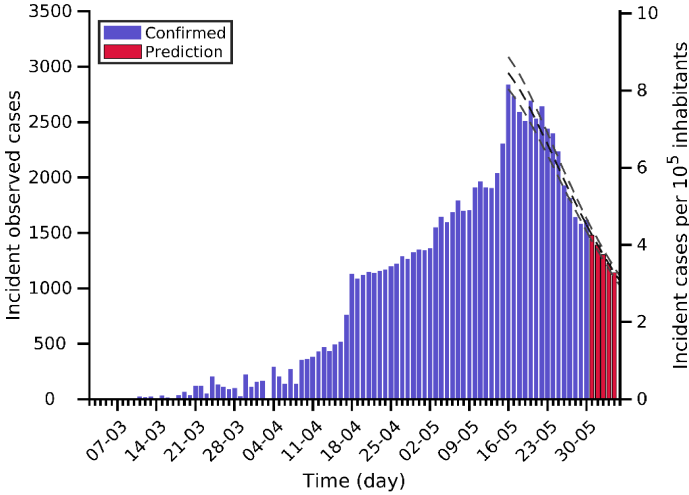
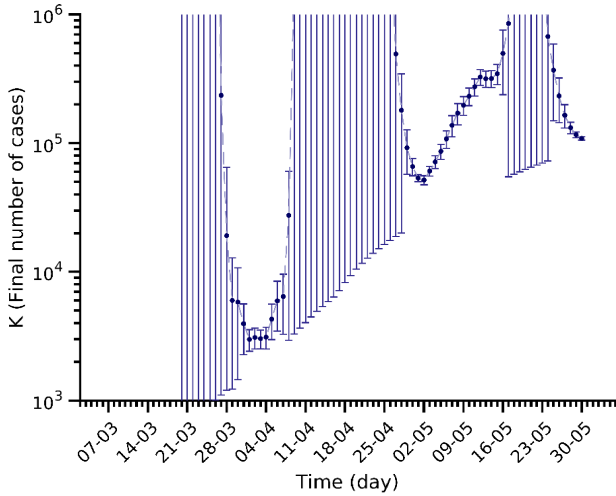
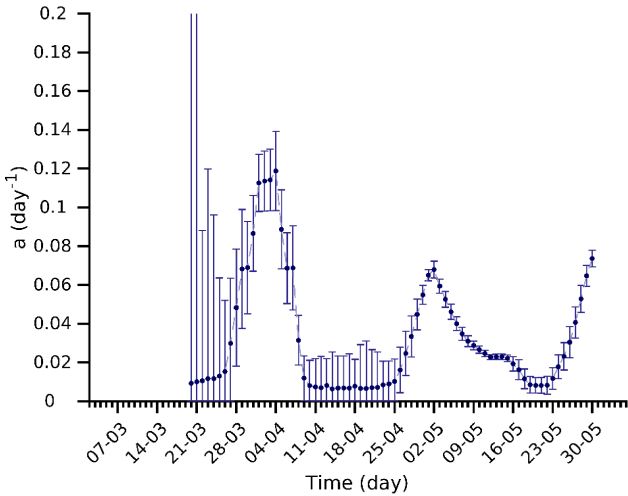
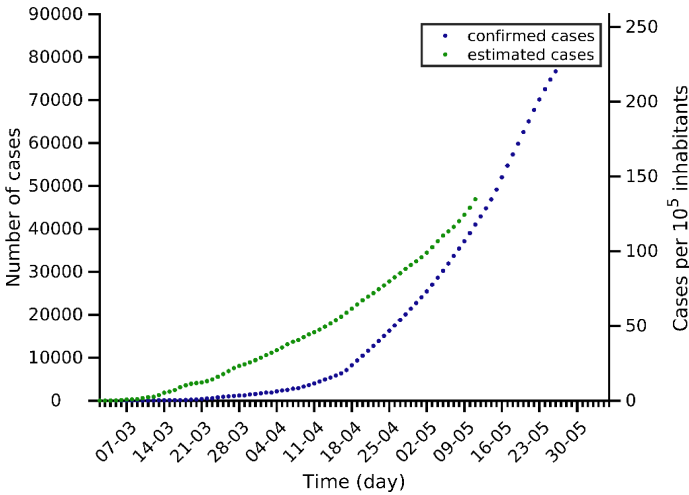
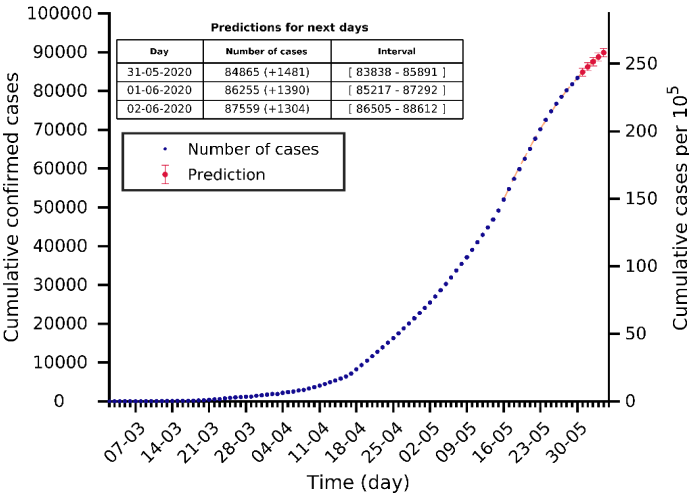


# Canada 30-05-2020. Population: 37.7M. Current cumulated incidence: 239/10<sup>5</sup>



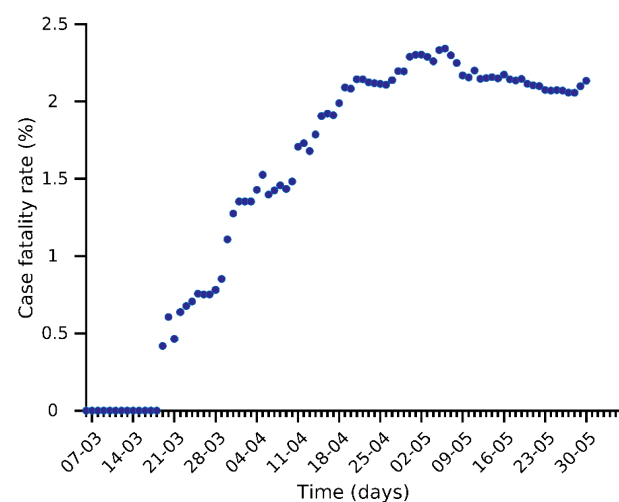
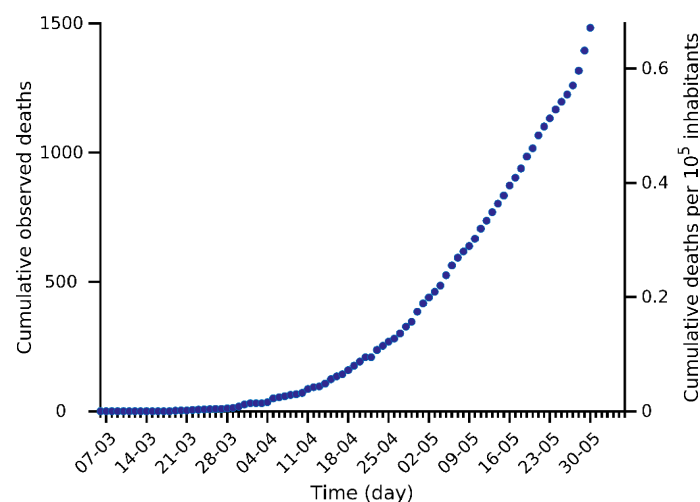
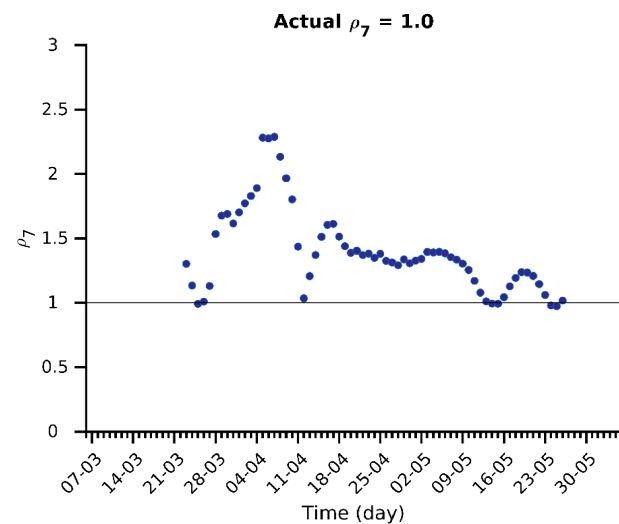
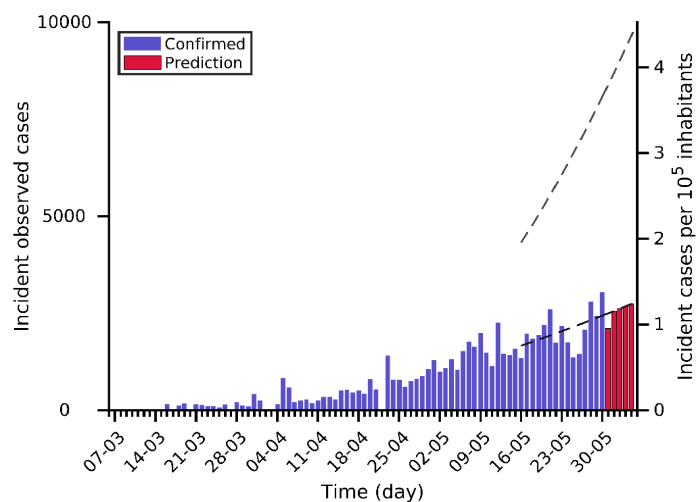
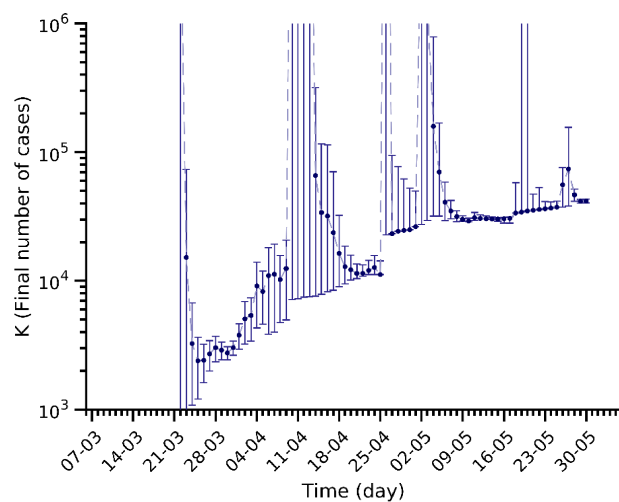
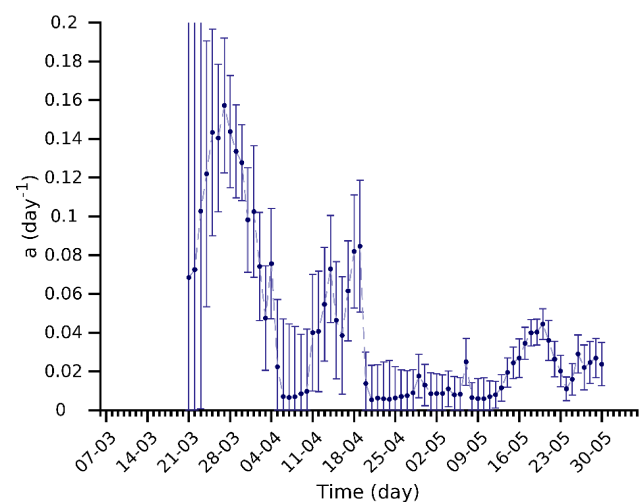
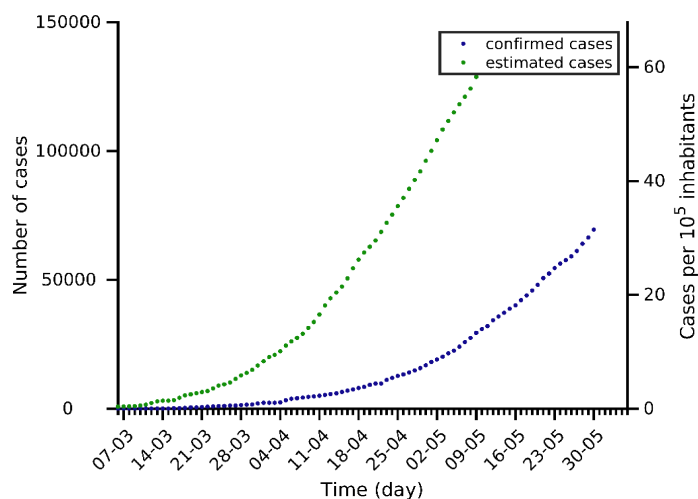
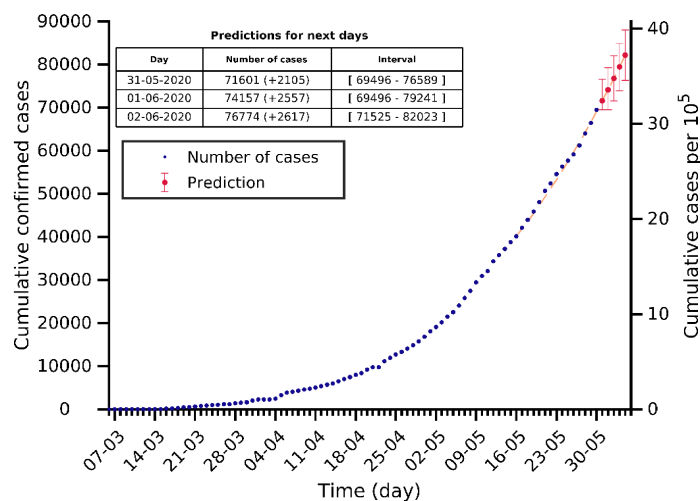
# Mexico 30-05-2020. Population: 128.9M. Current cumulated incidence: 68/10<sup>5</sup>



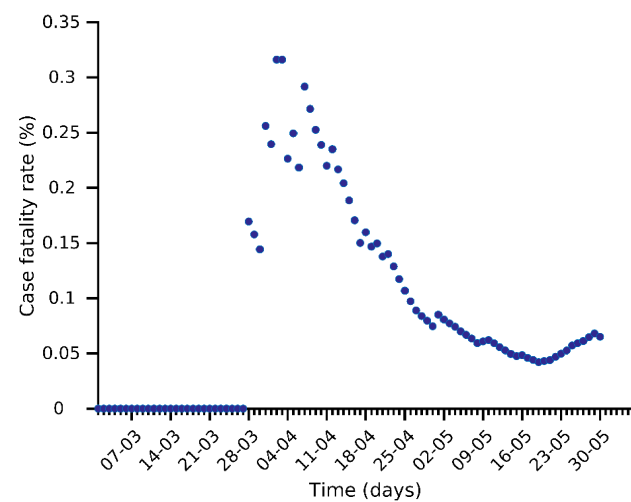
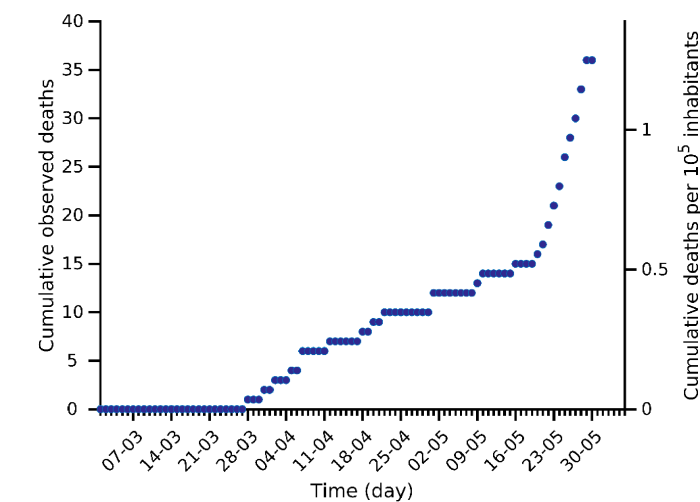
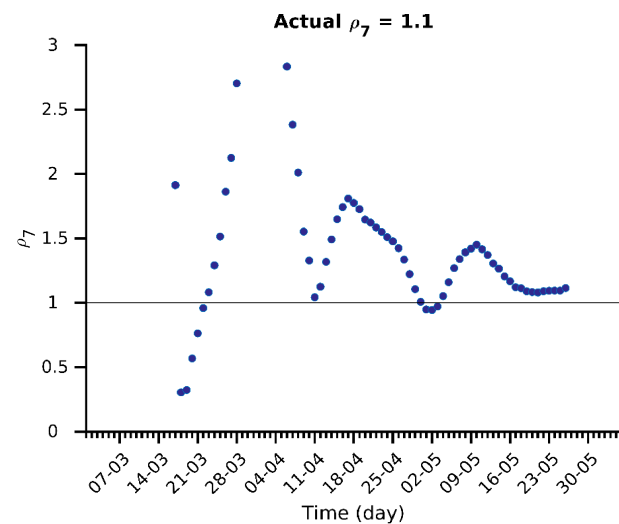
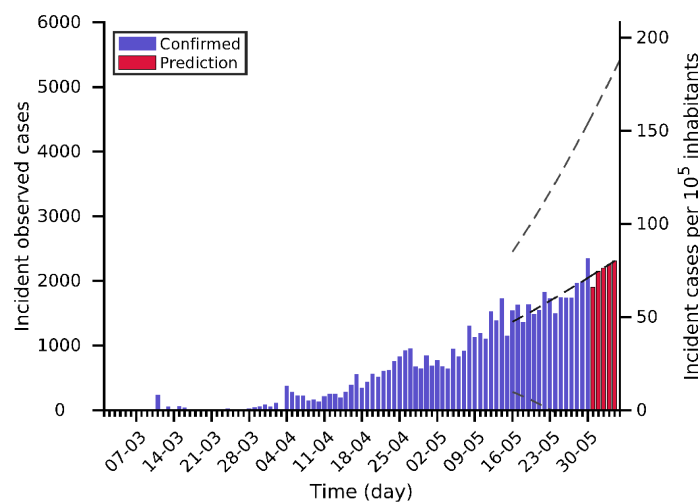
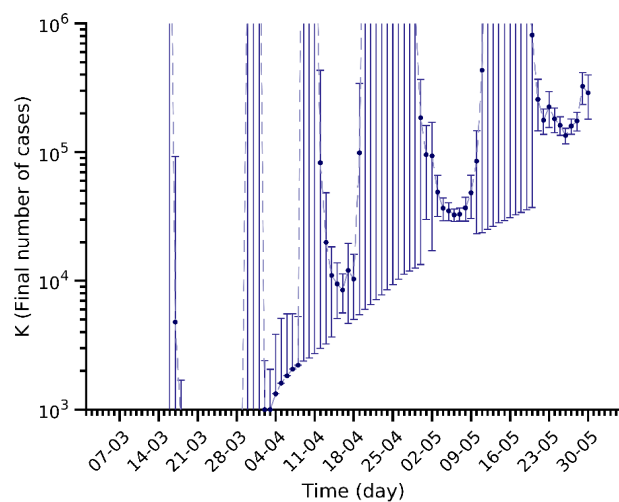
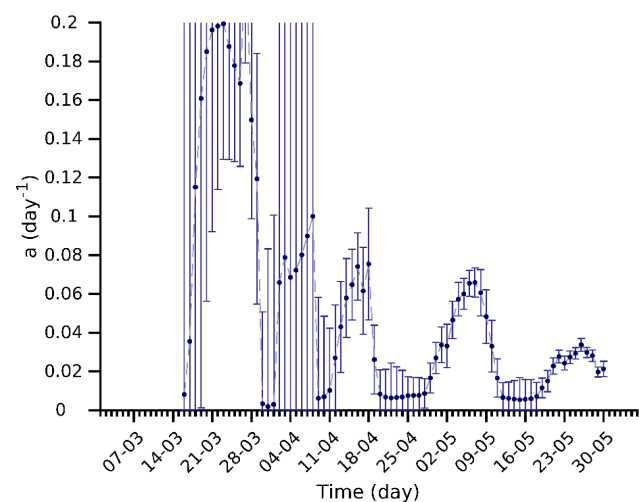
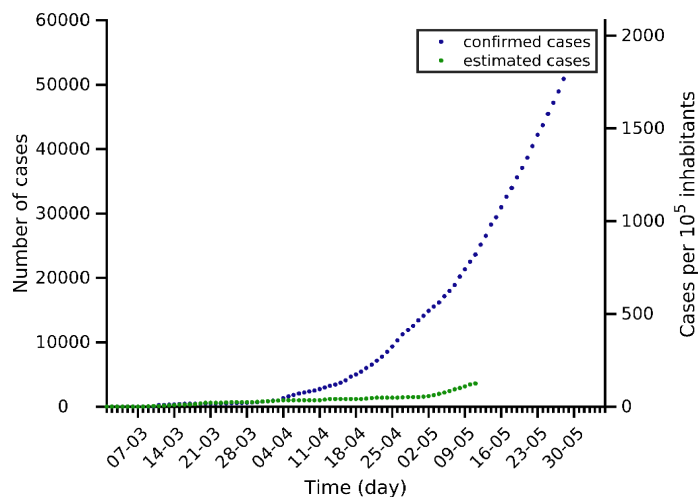
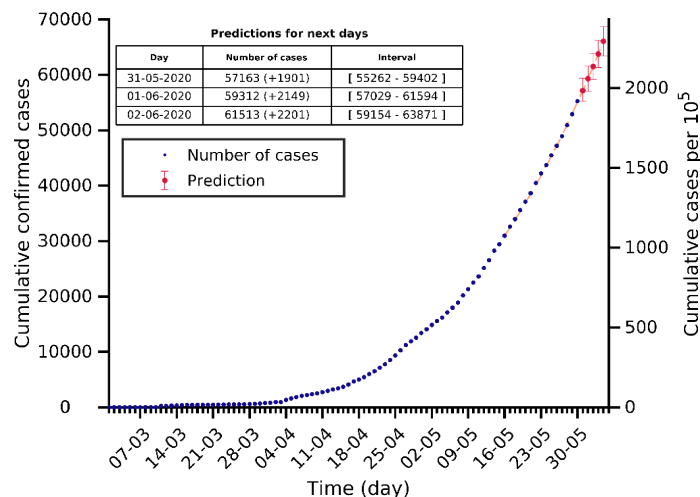




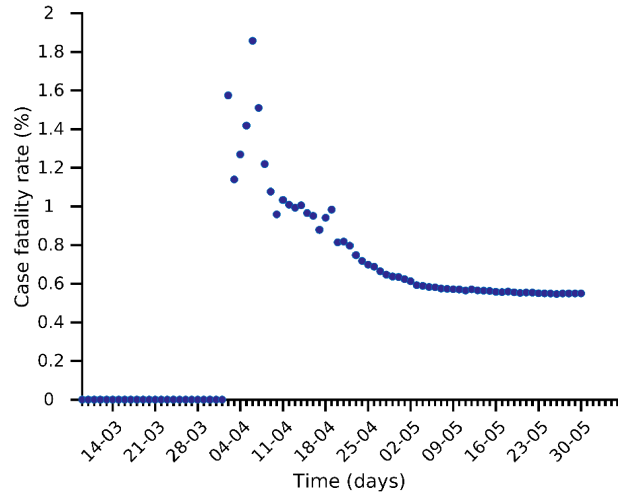
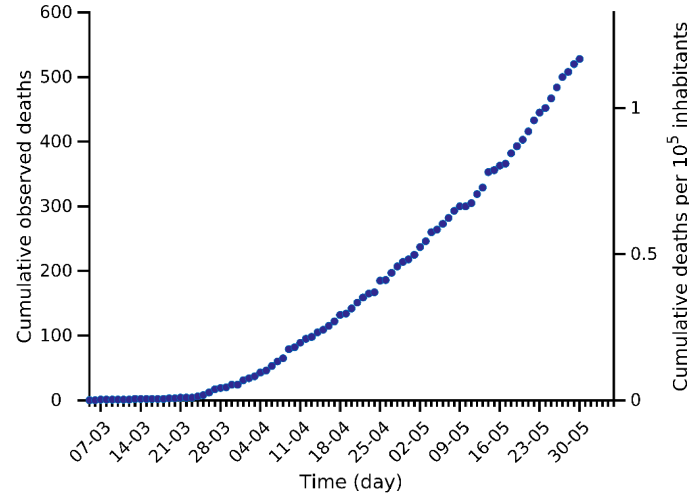
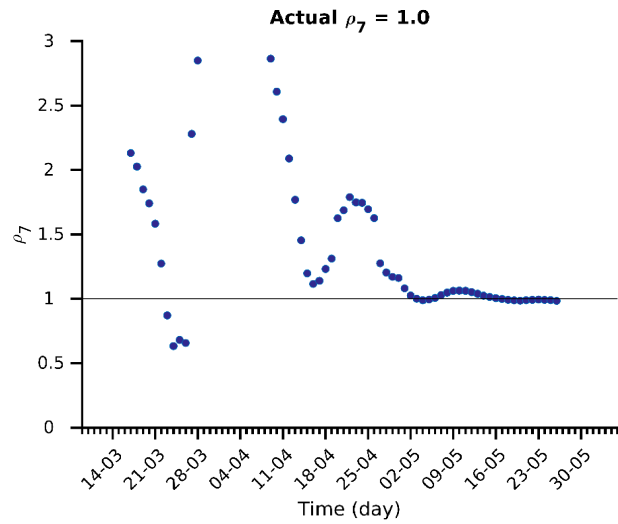
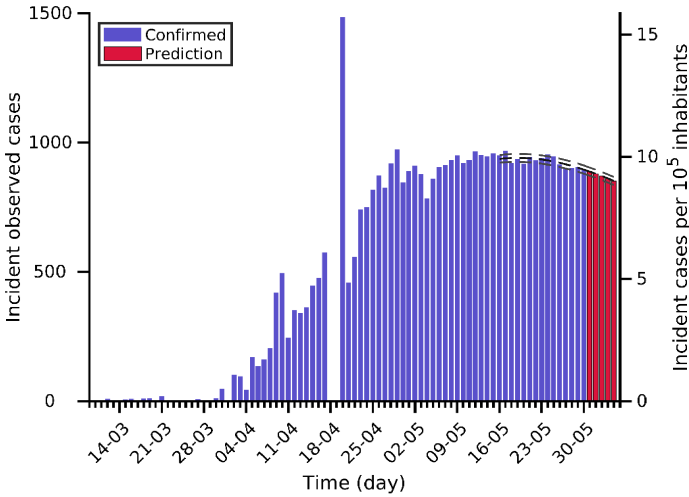
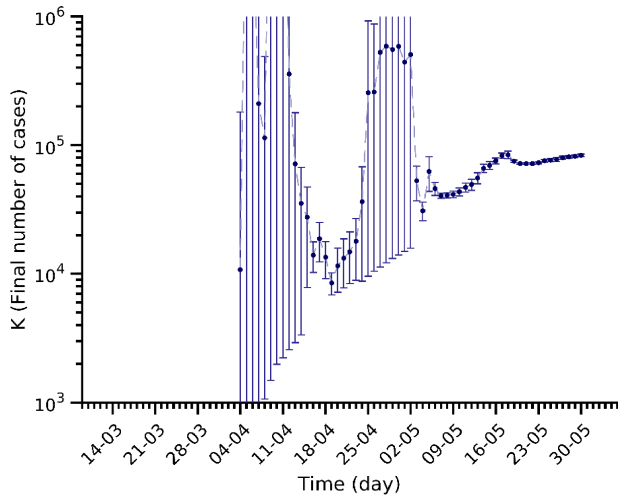
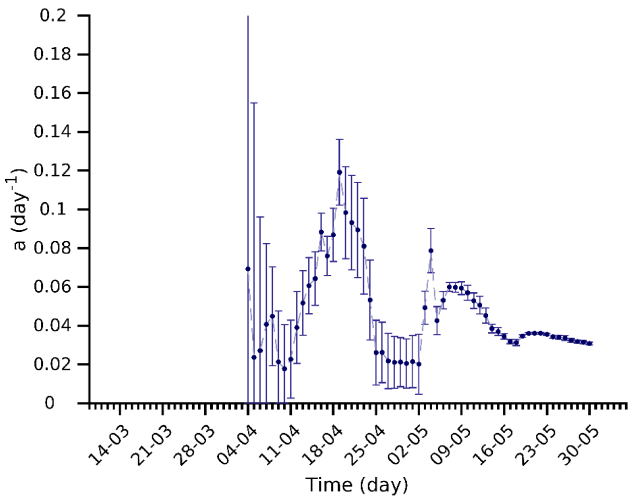
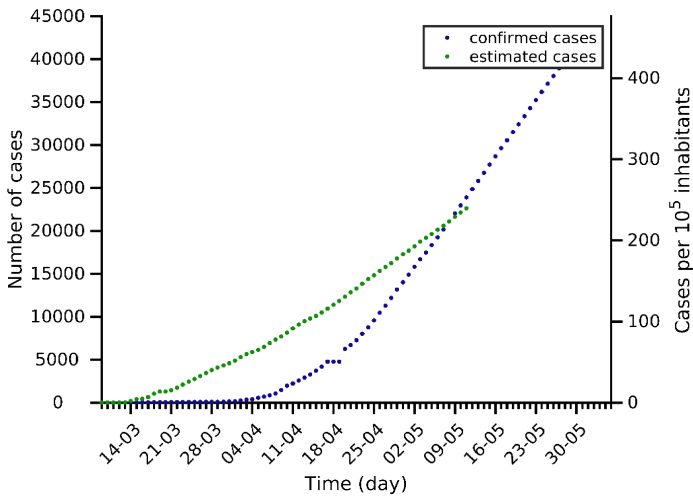
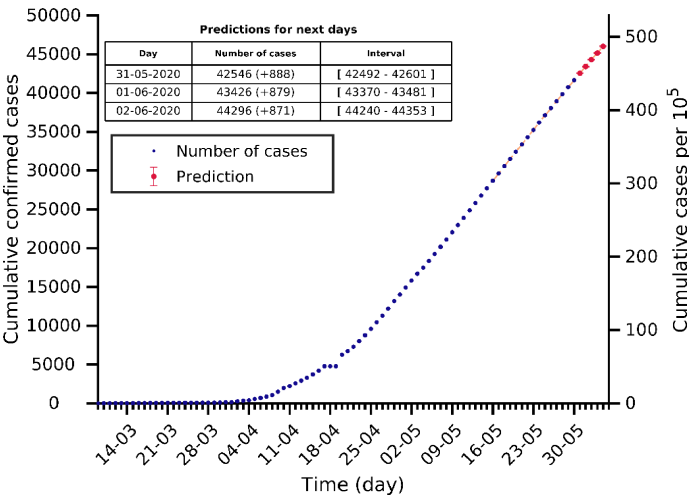
# Pakistan 30-05-2020. Population: 220.9M. Current cumulated incidence: 31/10<sup>5</sup>



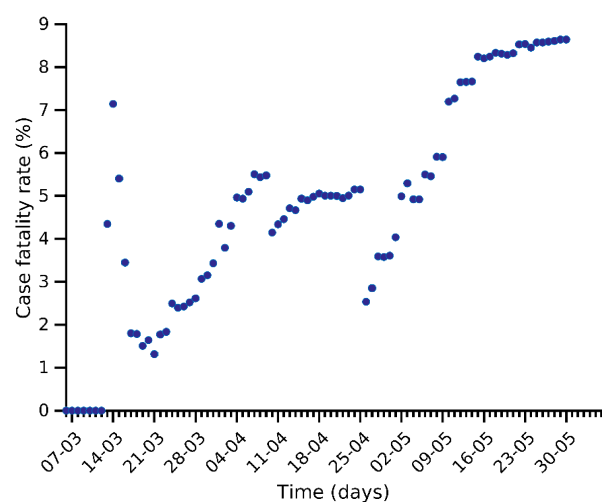
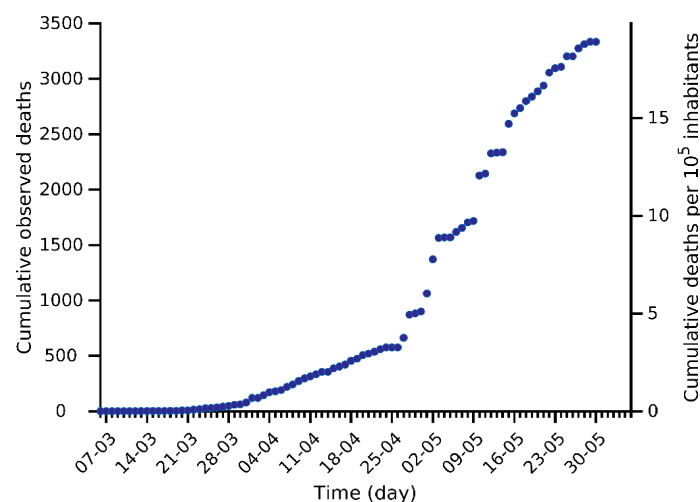
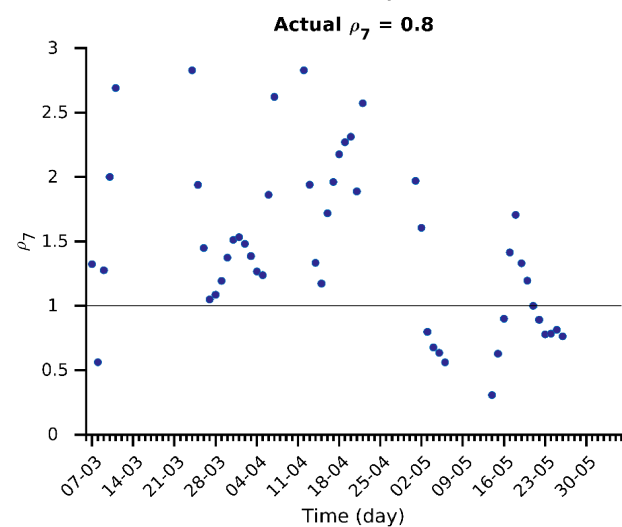
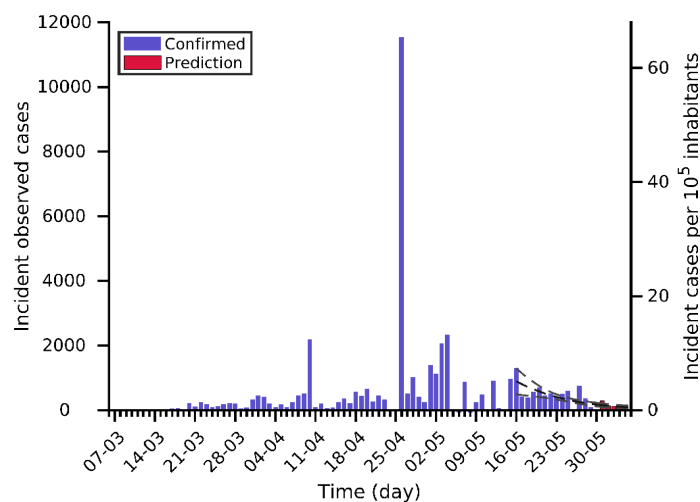
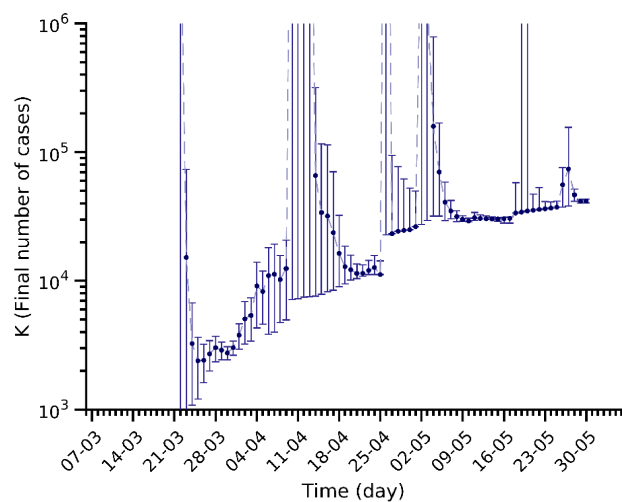
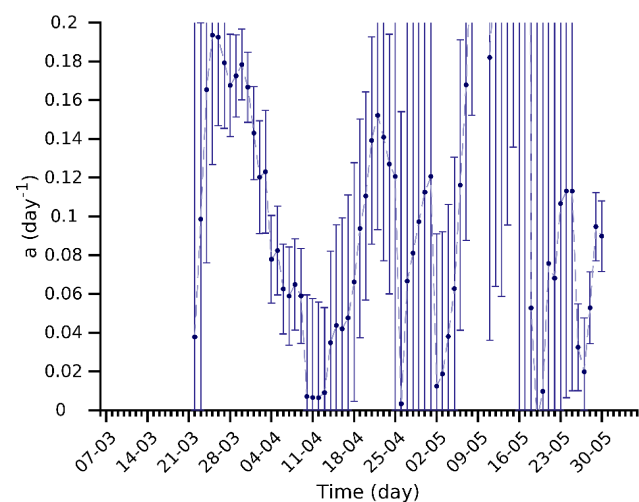
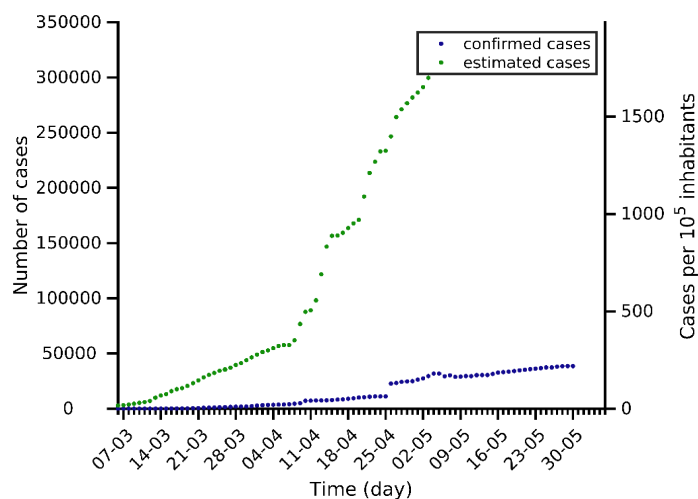
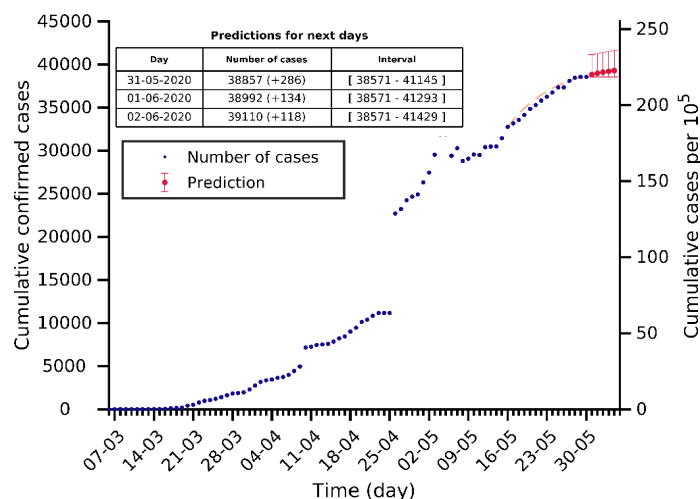
# Qatar 30-05-2020. Population: 2.9M. Current cumulated incidence: 1918/10<sup>5</sup>



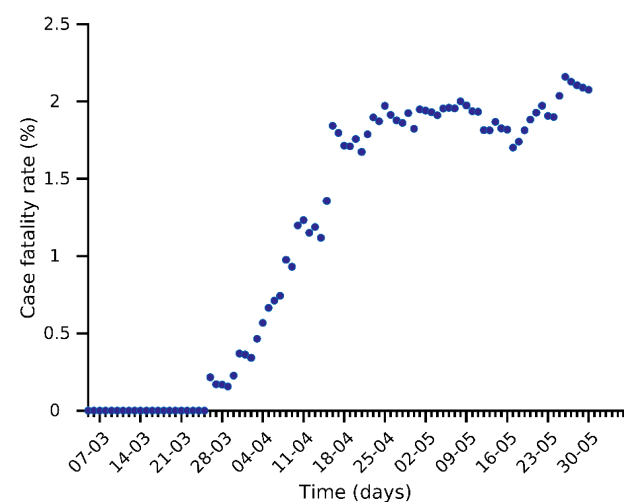
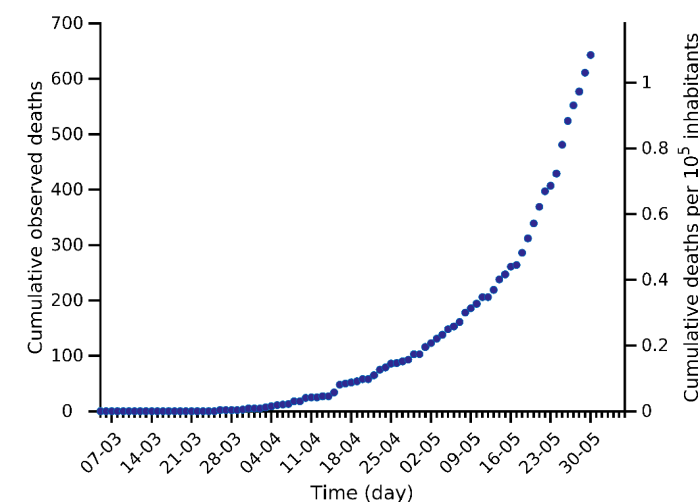
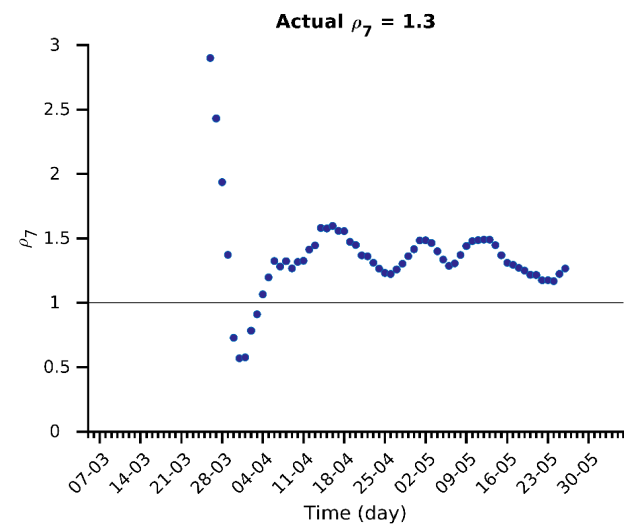
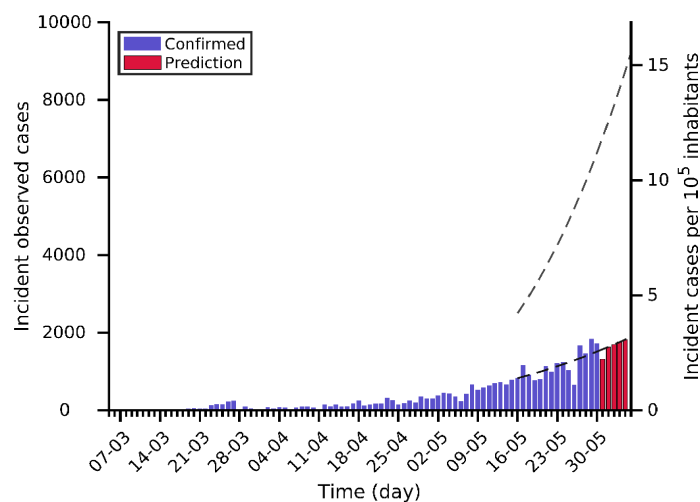
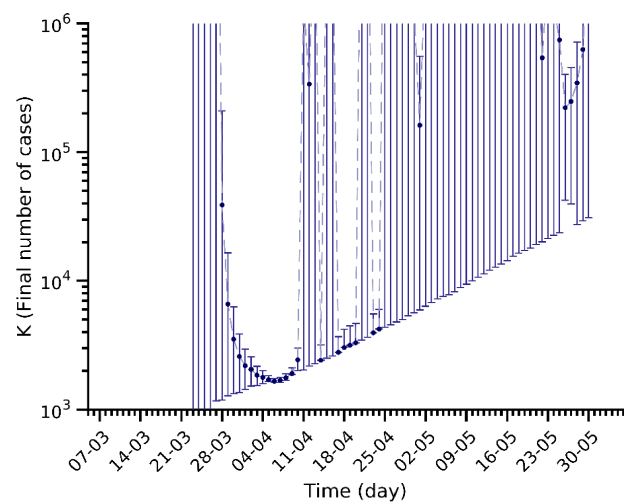
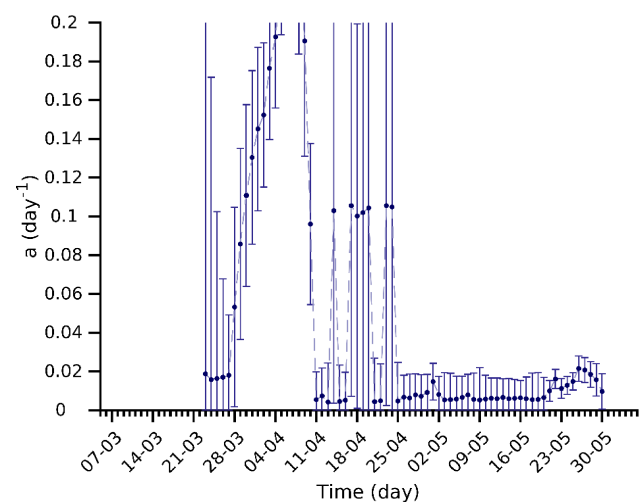
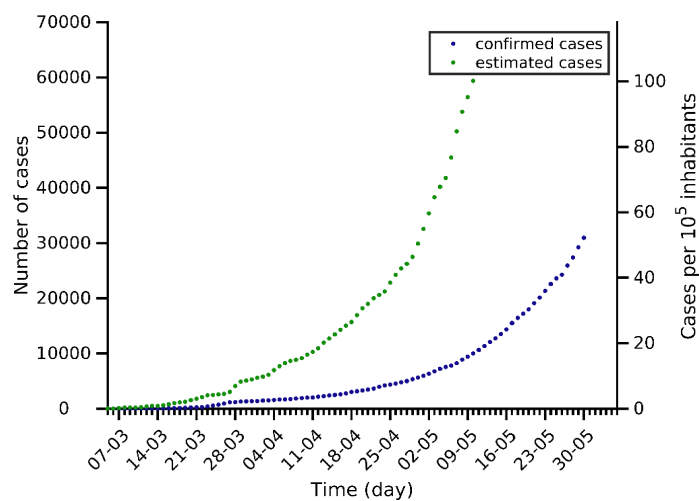
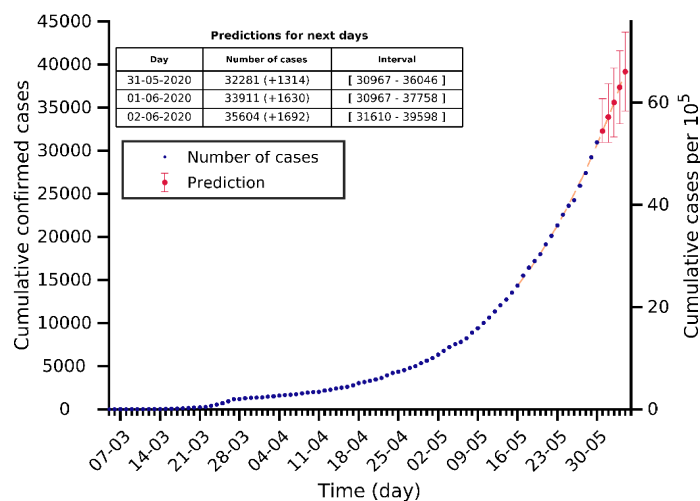
Belarus 30-05-2020. Population: 9.4M. Current cumulated incidence: 441/10<sup>5</sup>



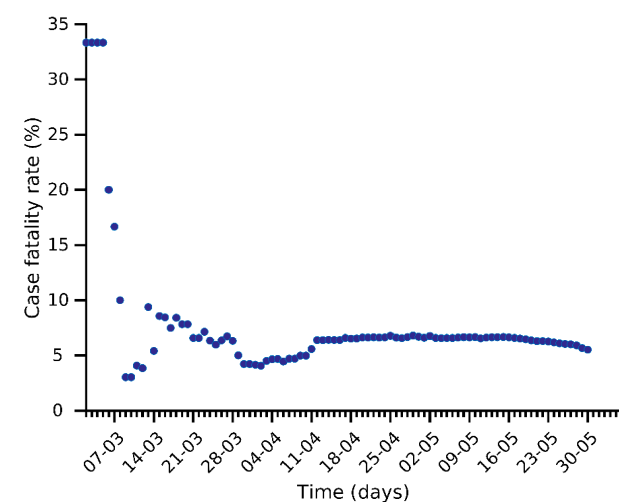
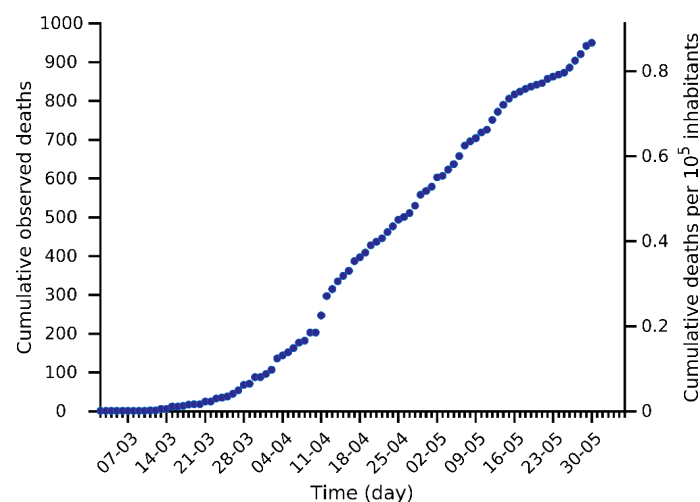
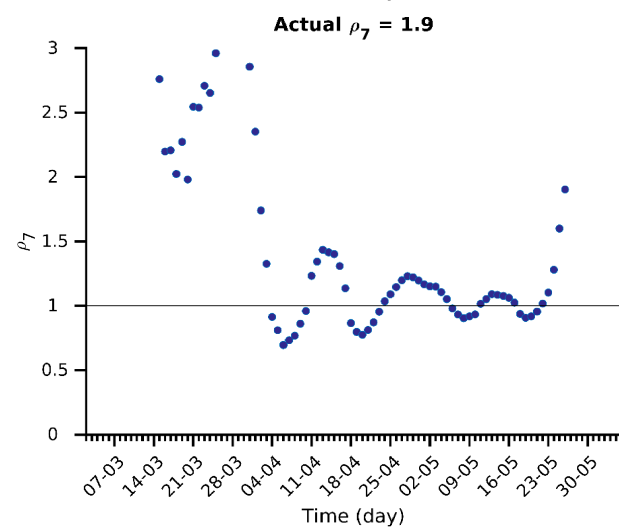
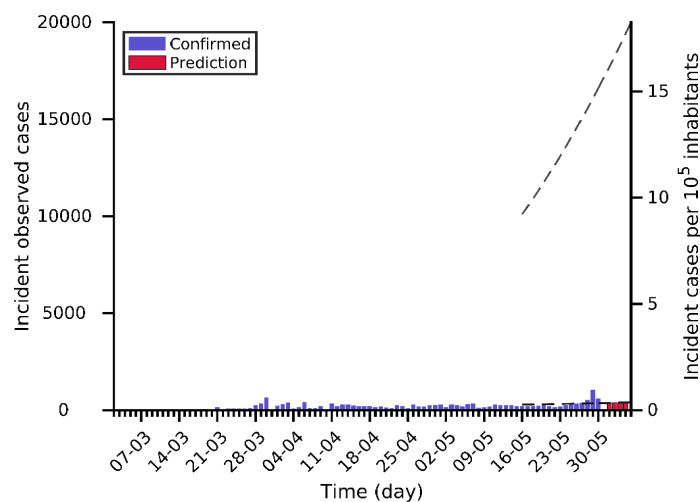
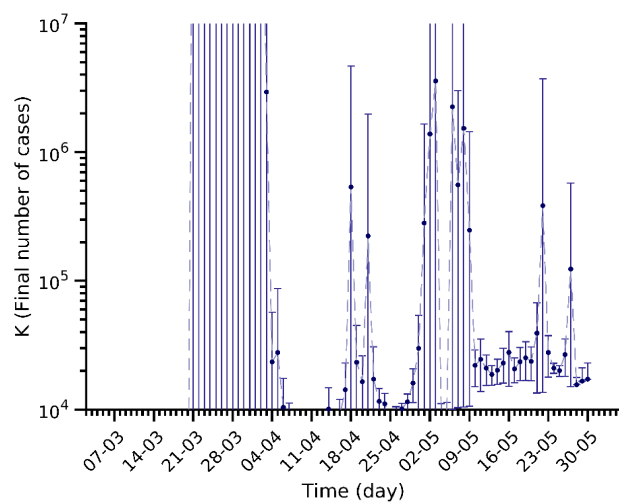
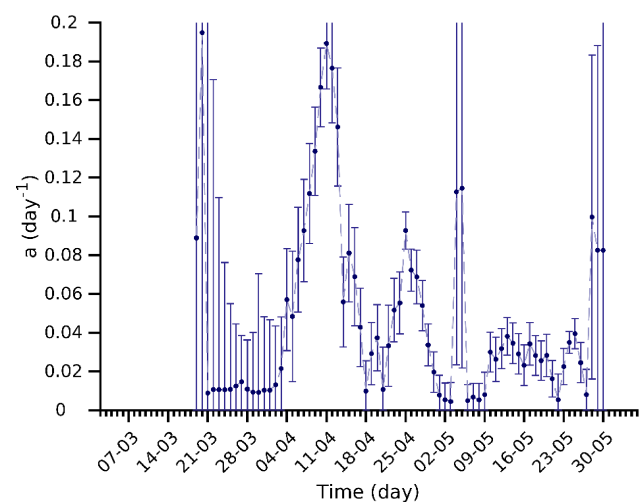
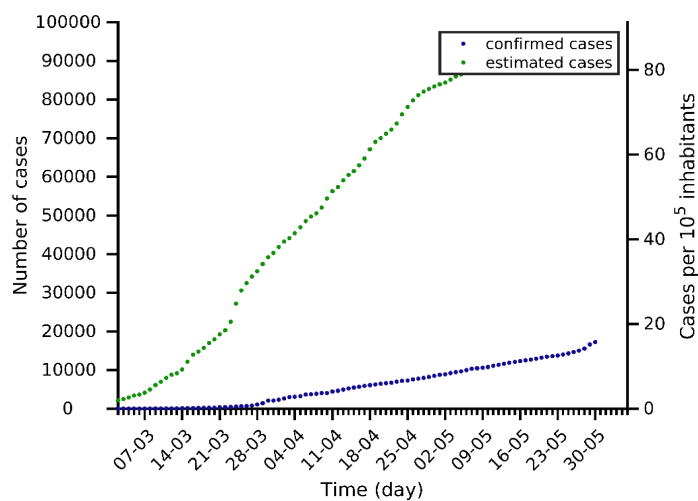
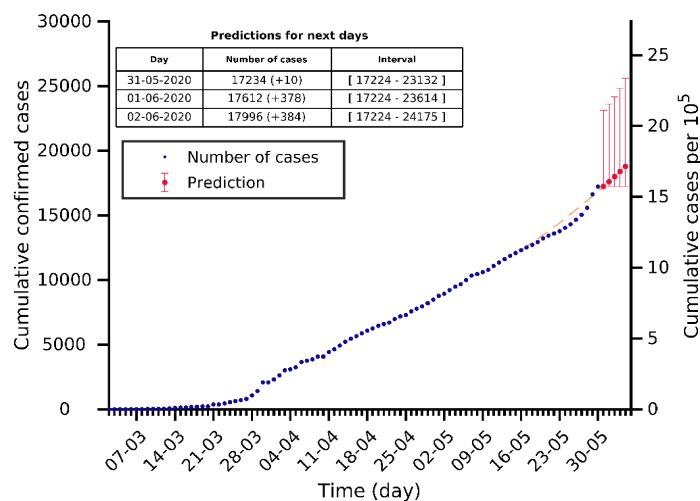
# Ecuador 30-05-2020. Population: 17.6M. Current cumulated incidence: 219/10<sup>5</sup>



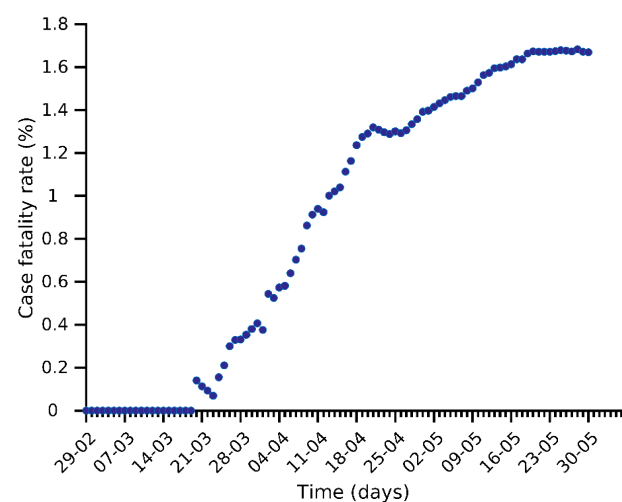
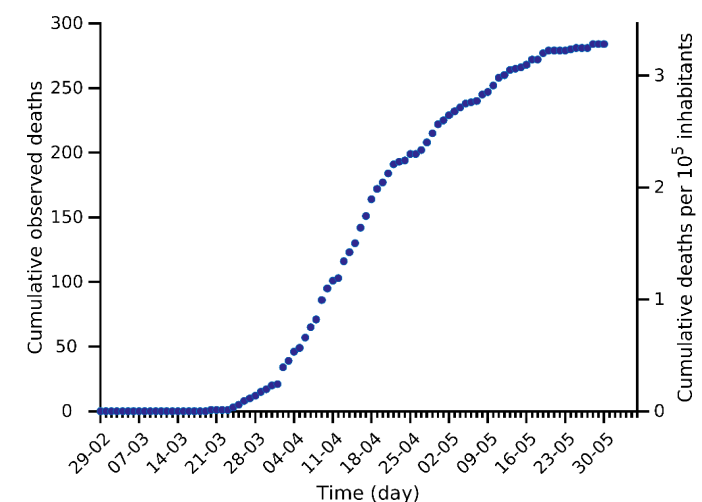
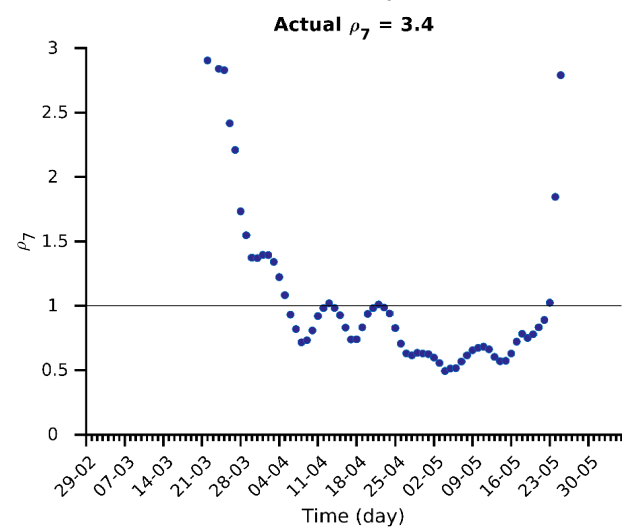
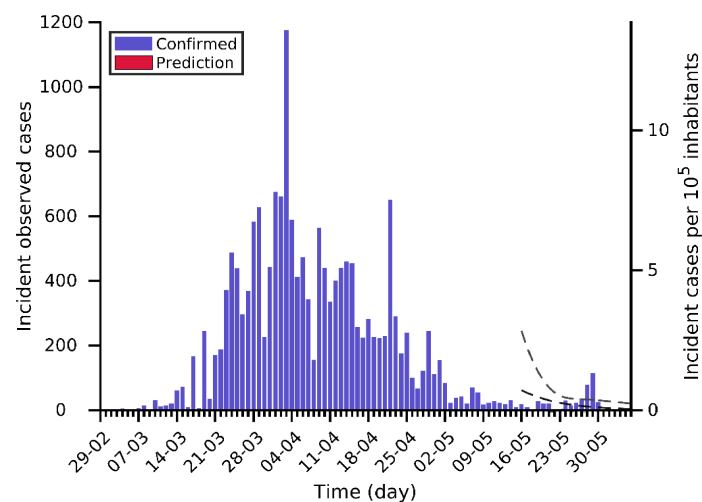
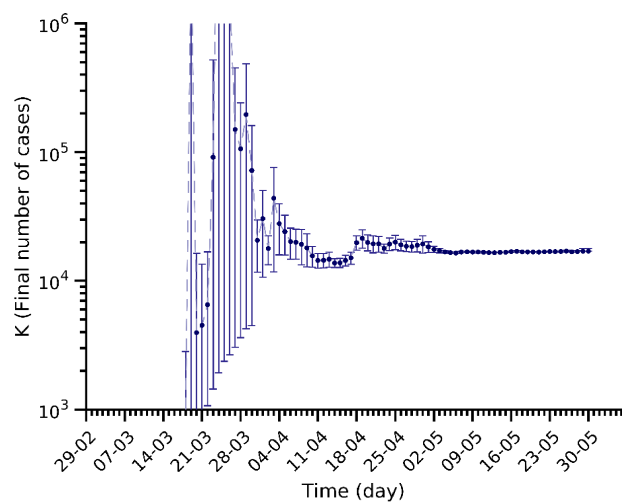
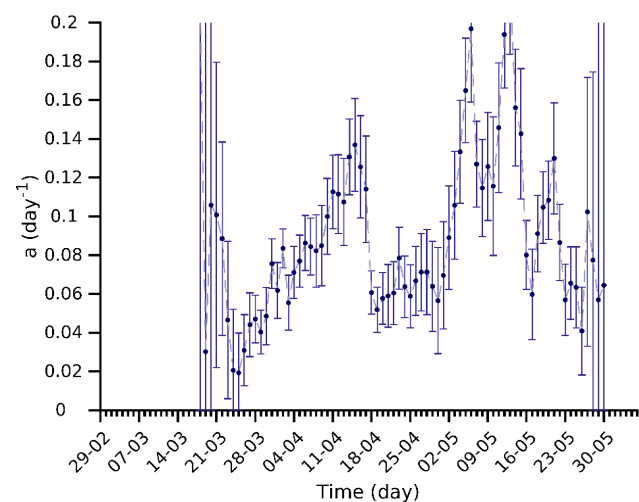
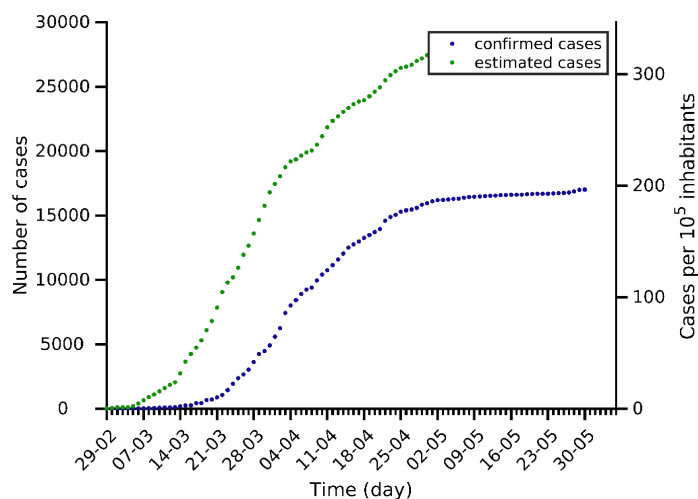
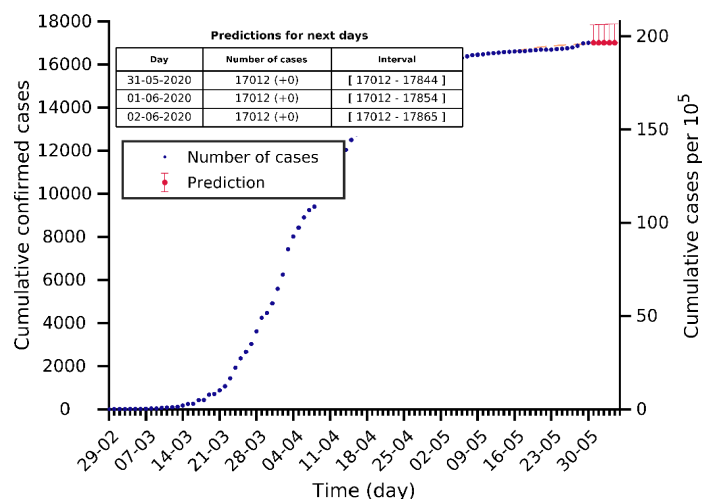
# South Africa 30-05-2020. Population: 59.3M. Current cumulated incidence: 52/10<sup>5</sup>



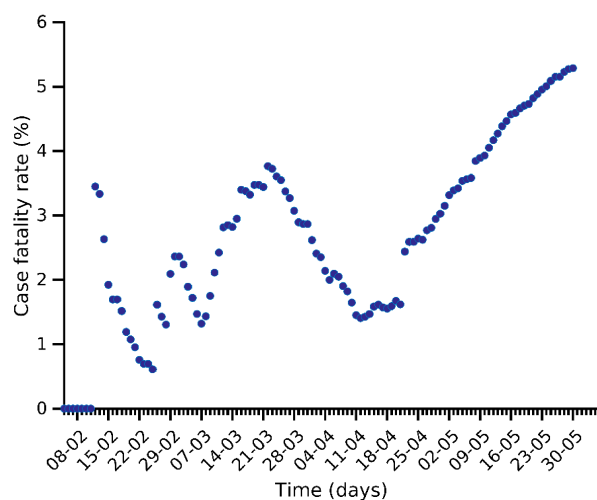
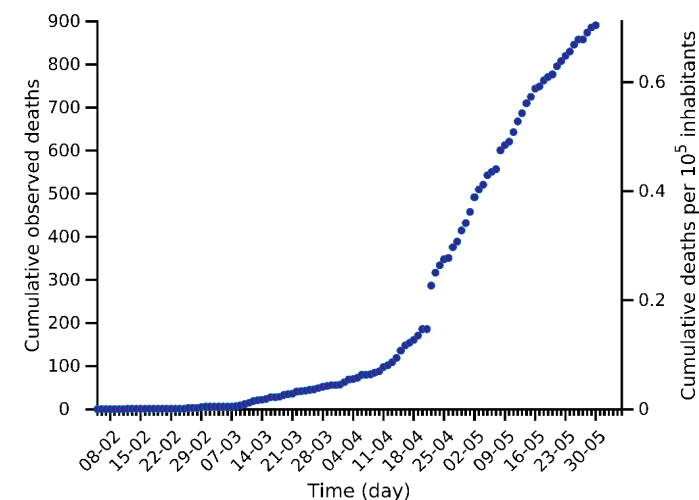
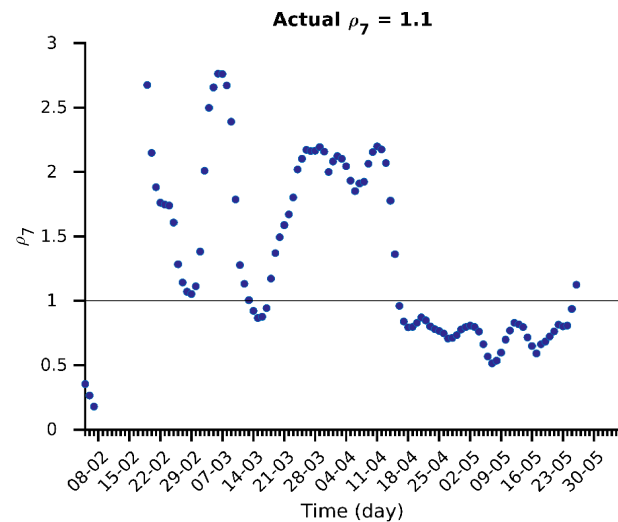
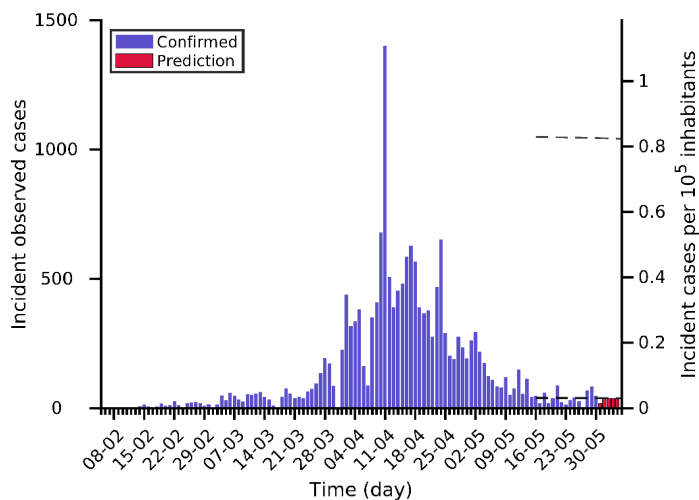
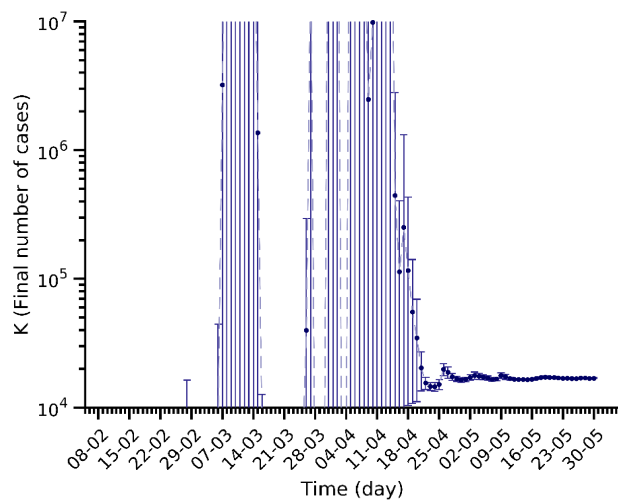
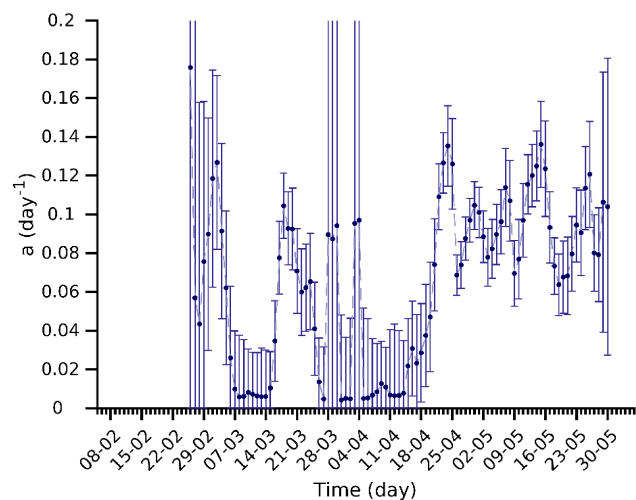
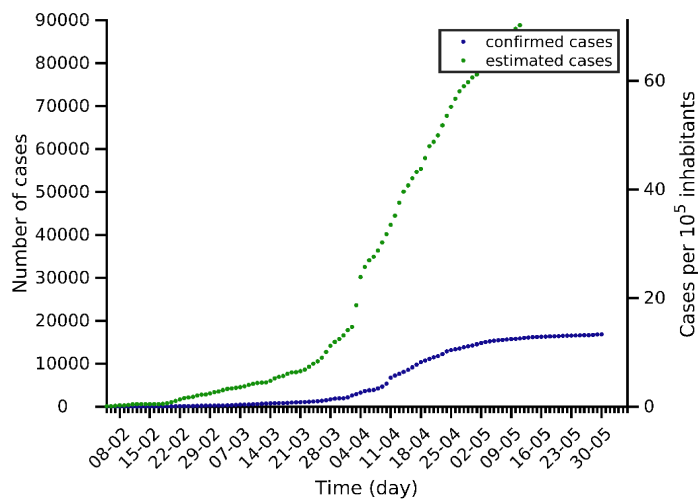
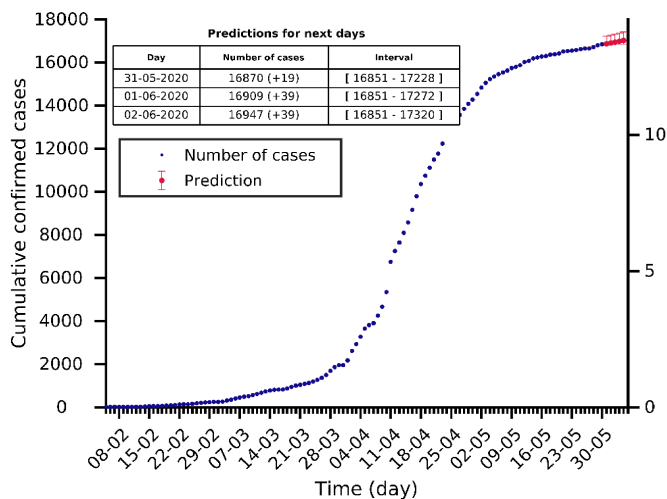
# Philippines 30-05-2020. Population: 109.6M. Current cumulated incidence: 16/10<sup>5</sup>



# Israel 30-05-2020. Population: 8.7M. Current cumulated incidence: 197/10<sup>5</sup>

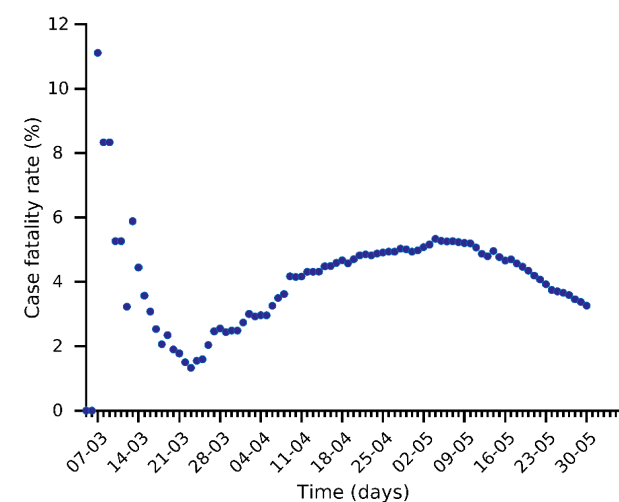
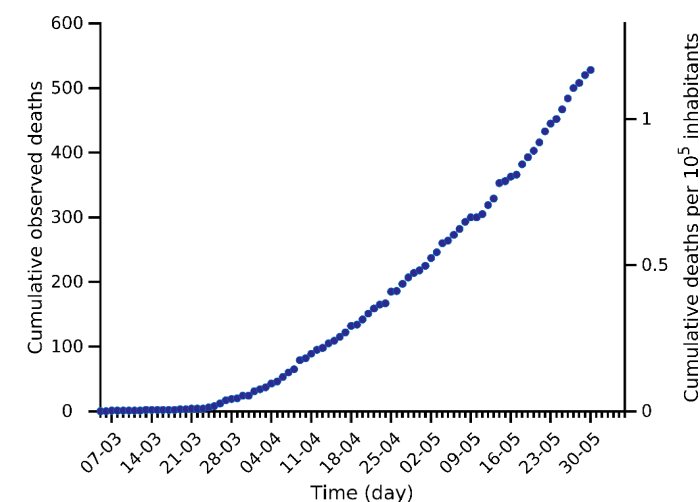
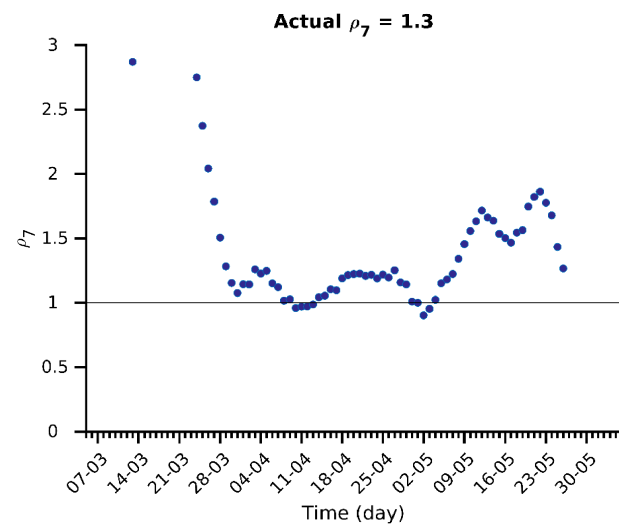
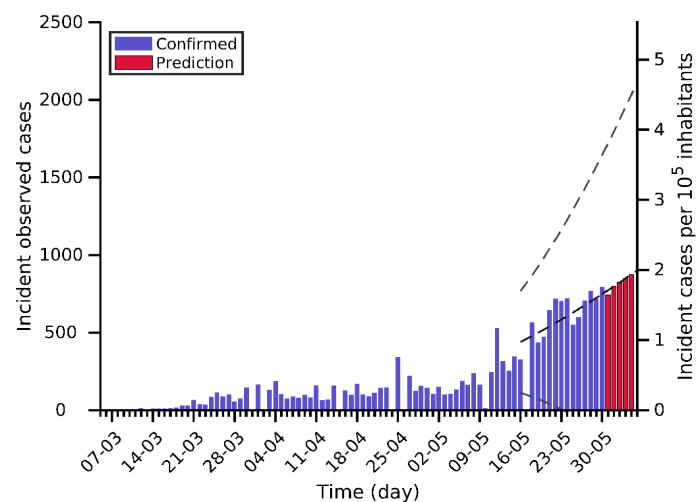
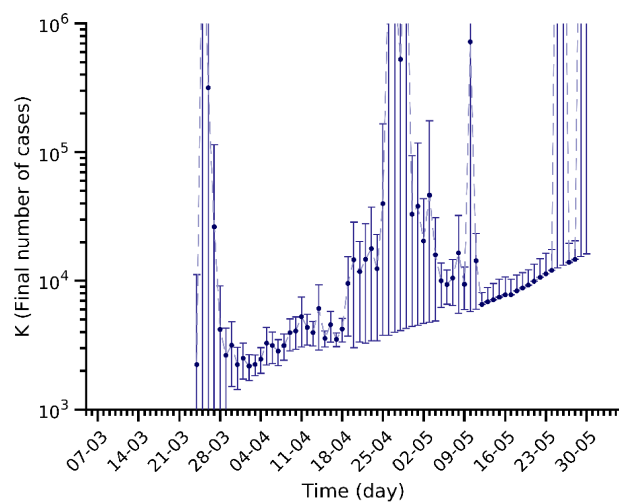
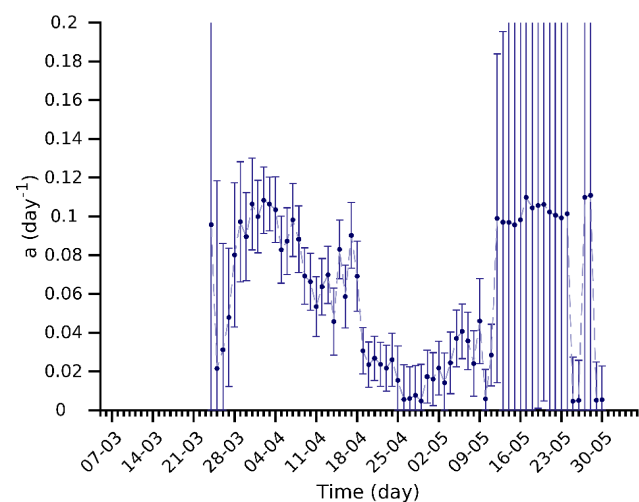
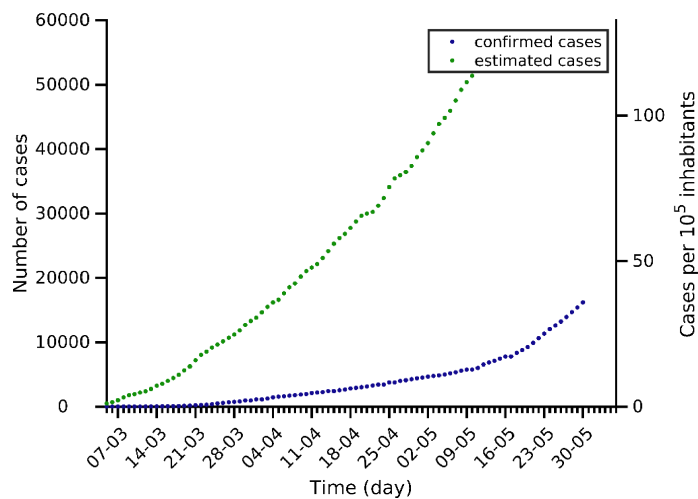
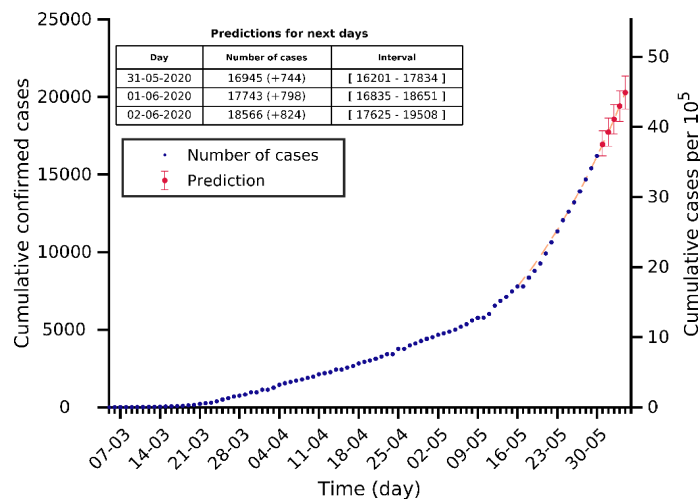


# Japan 30-05-2020. Population: 126.5M. Current cumulated incidence: 13/10<sup>5</sup>

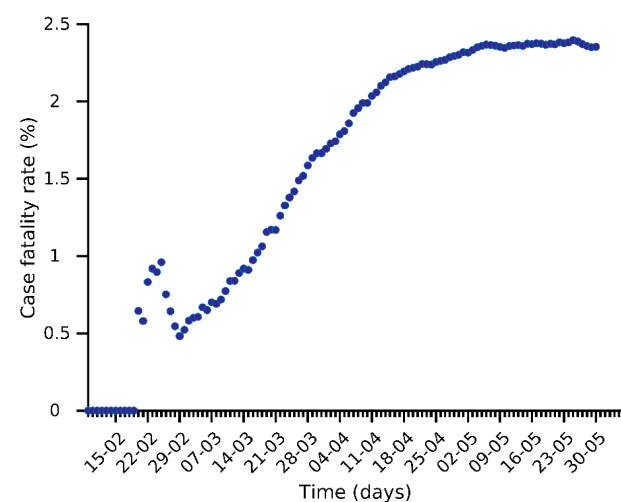
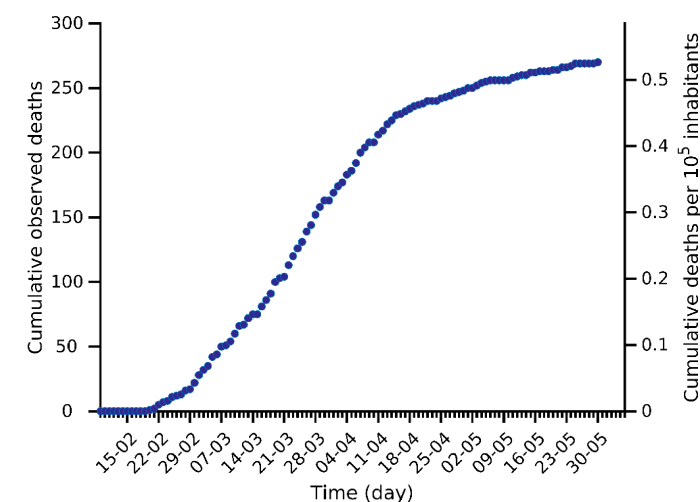
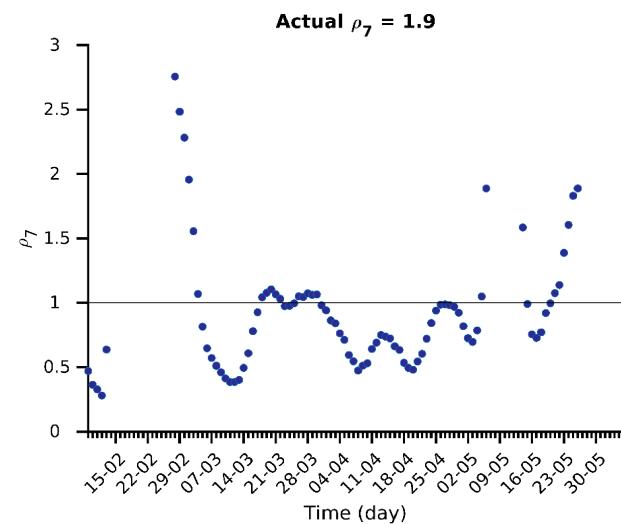
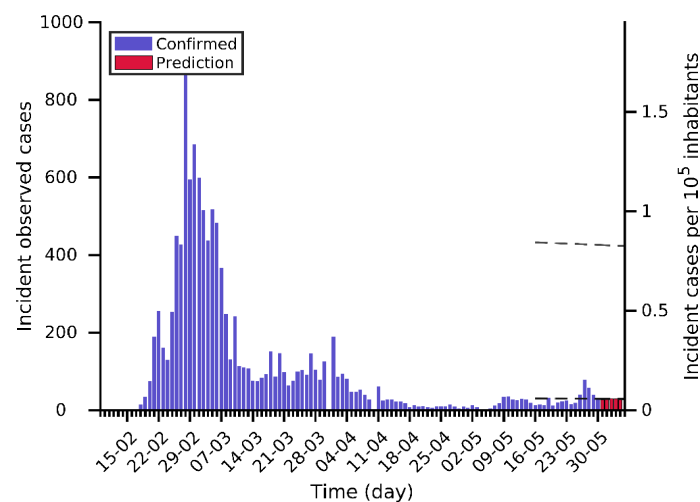
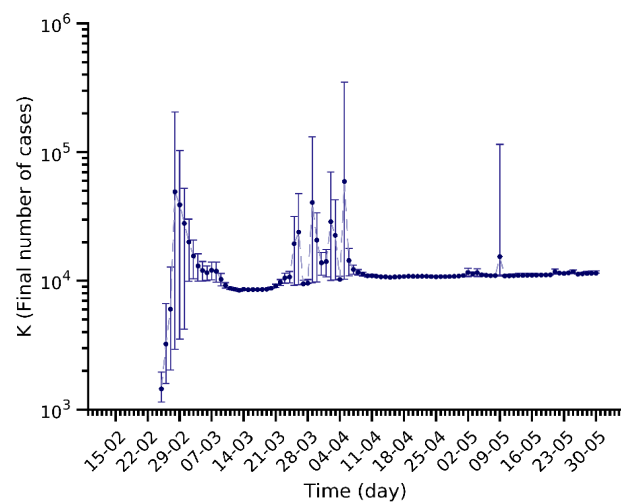
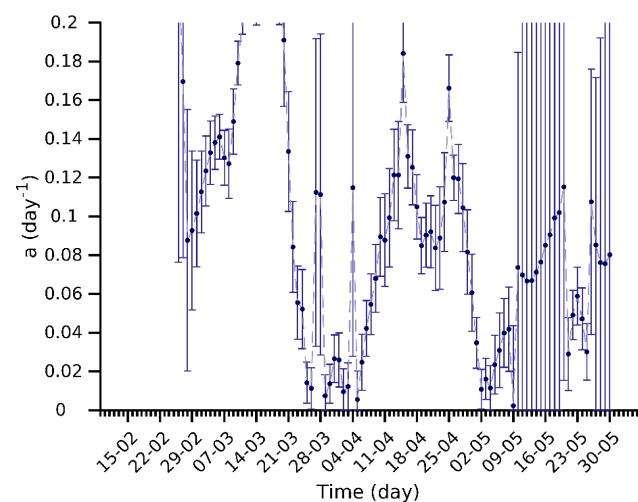
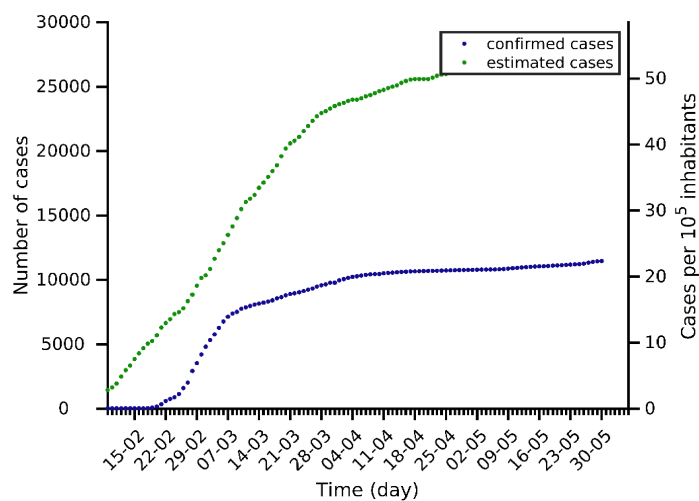
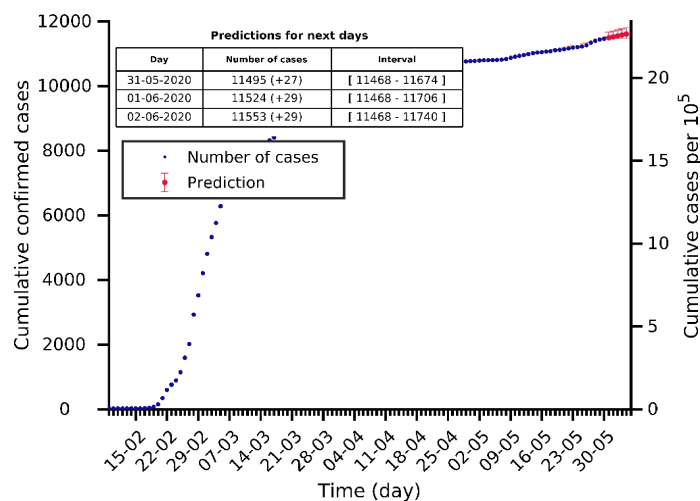




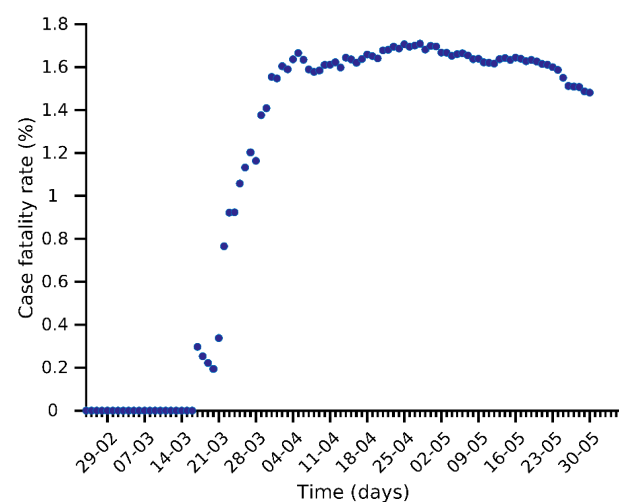
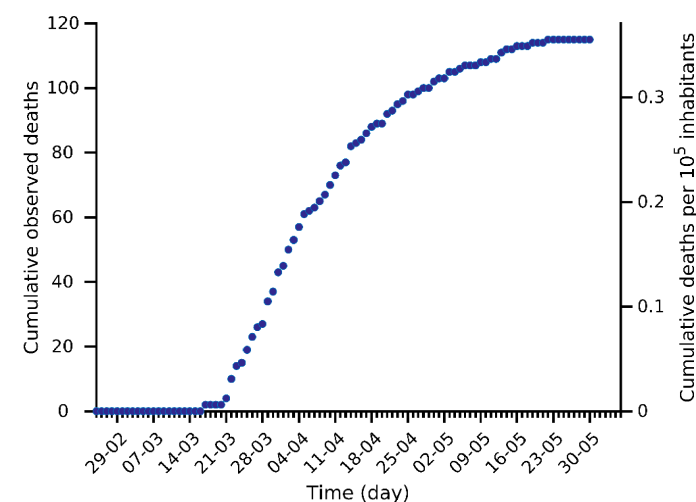
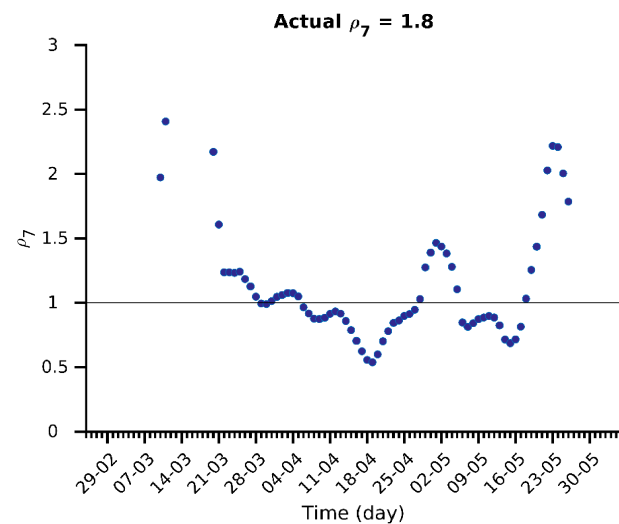
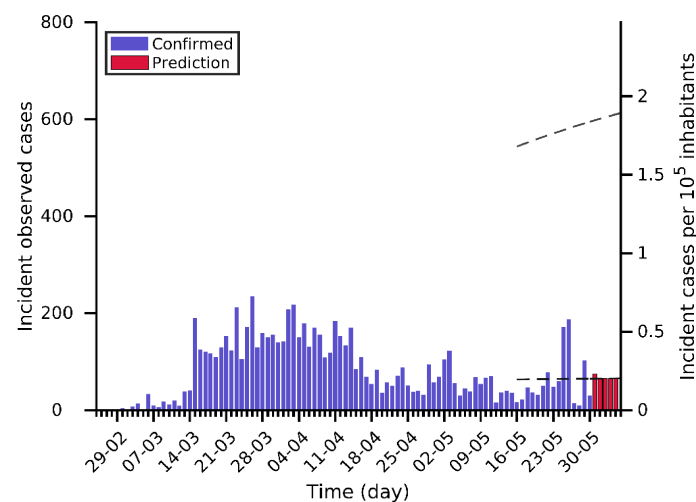
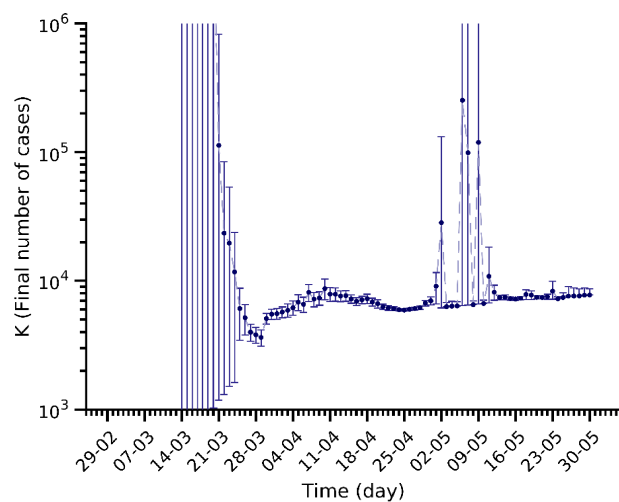
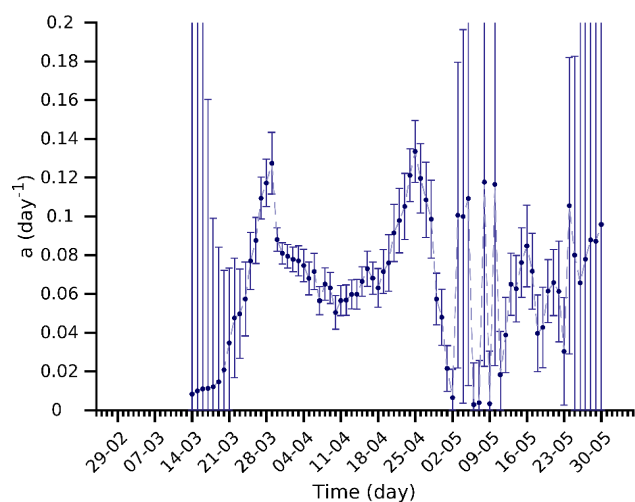
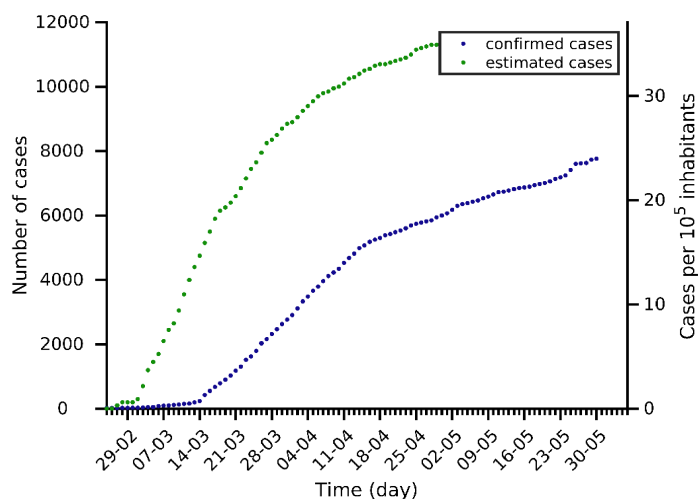
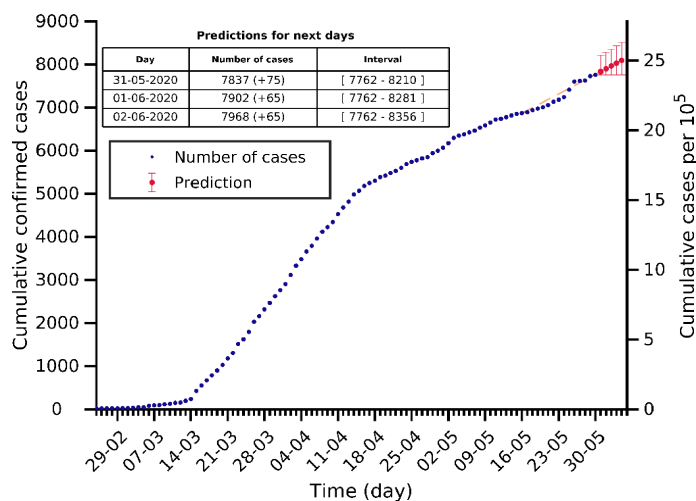
# Argentina 30-05-2020. Population: 45.2M. Current cumulated incidence: 36/10<sup>5</sup>



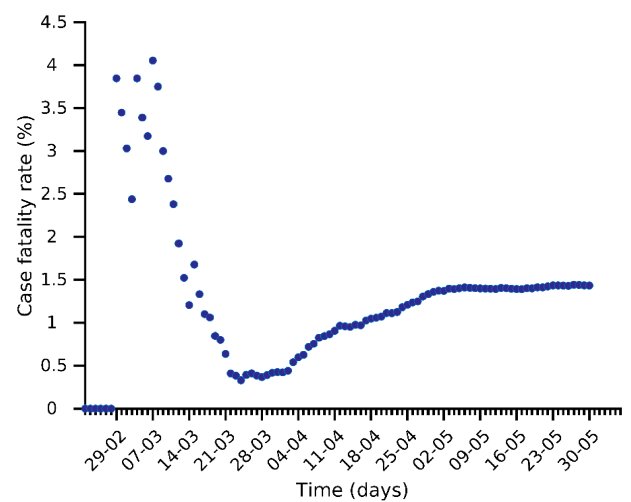
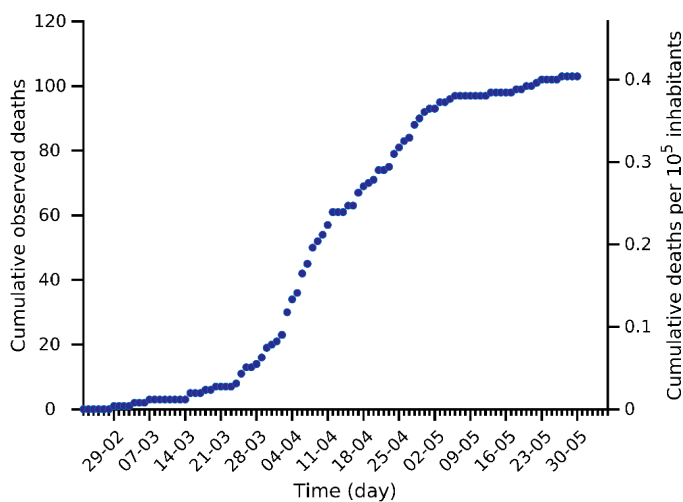
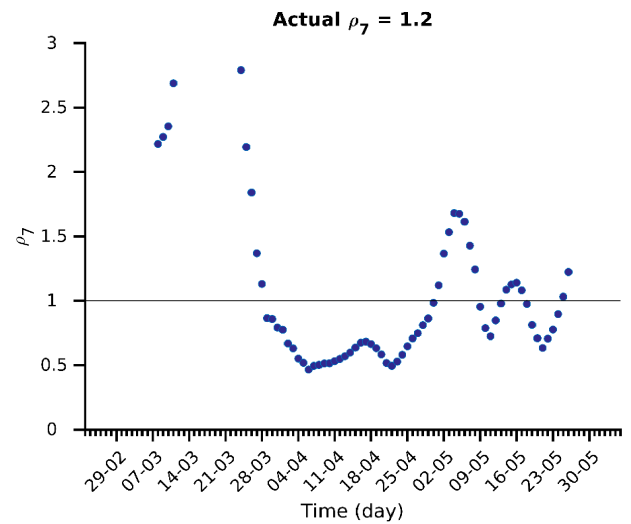
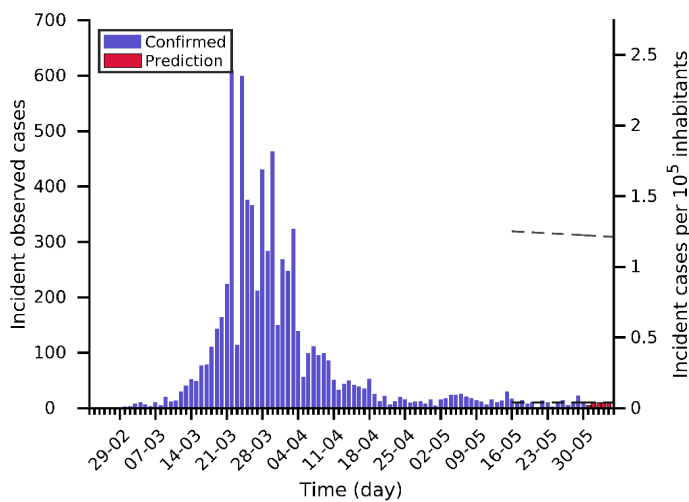
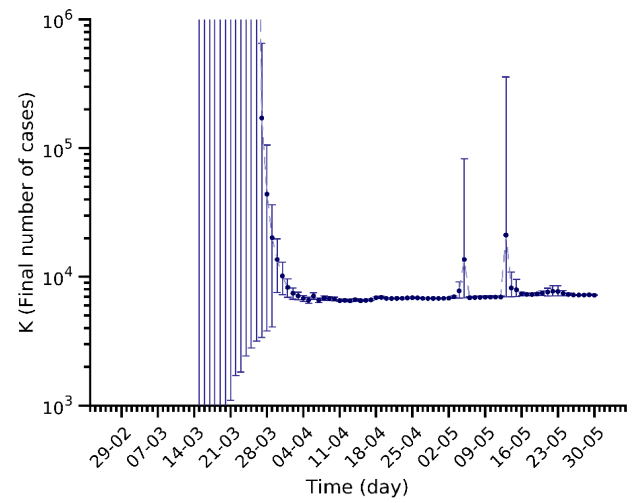
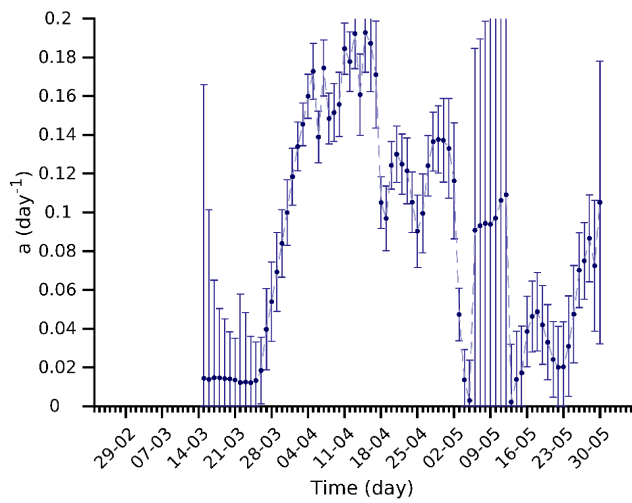
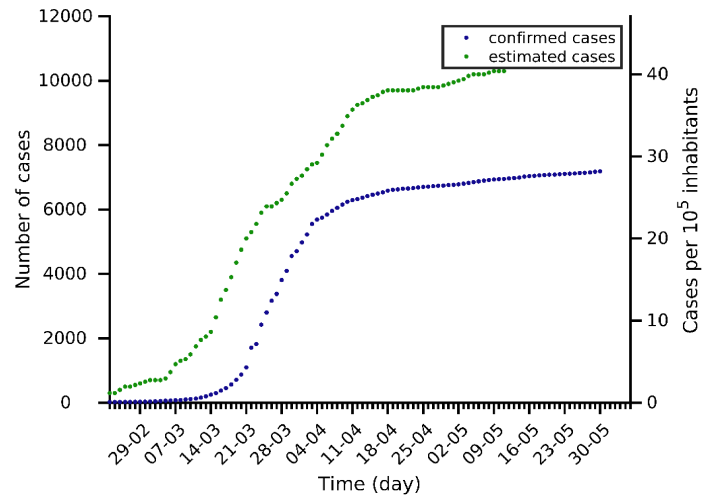
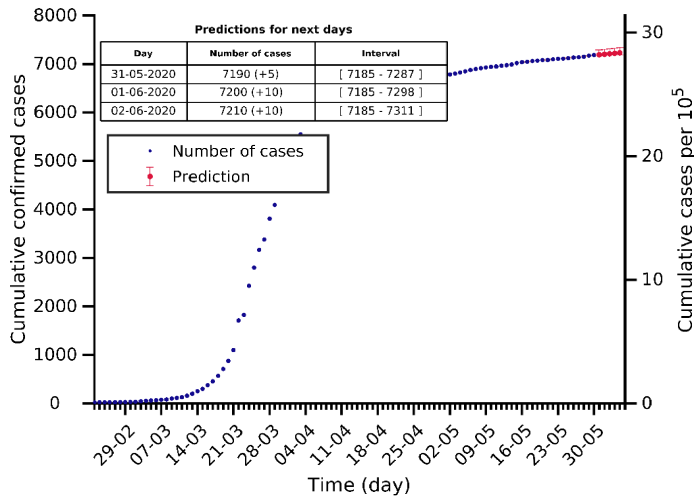
# South Korea 30-05-2020. Population: 51.3M. Current cumulated incidence: 22/10<sup>5</sup>



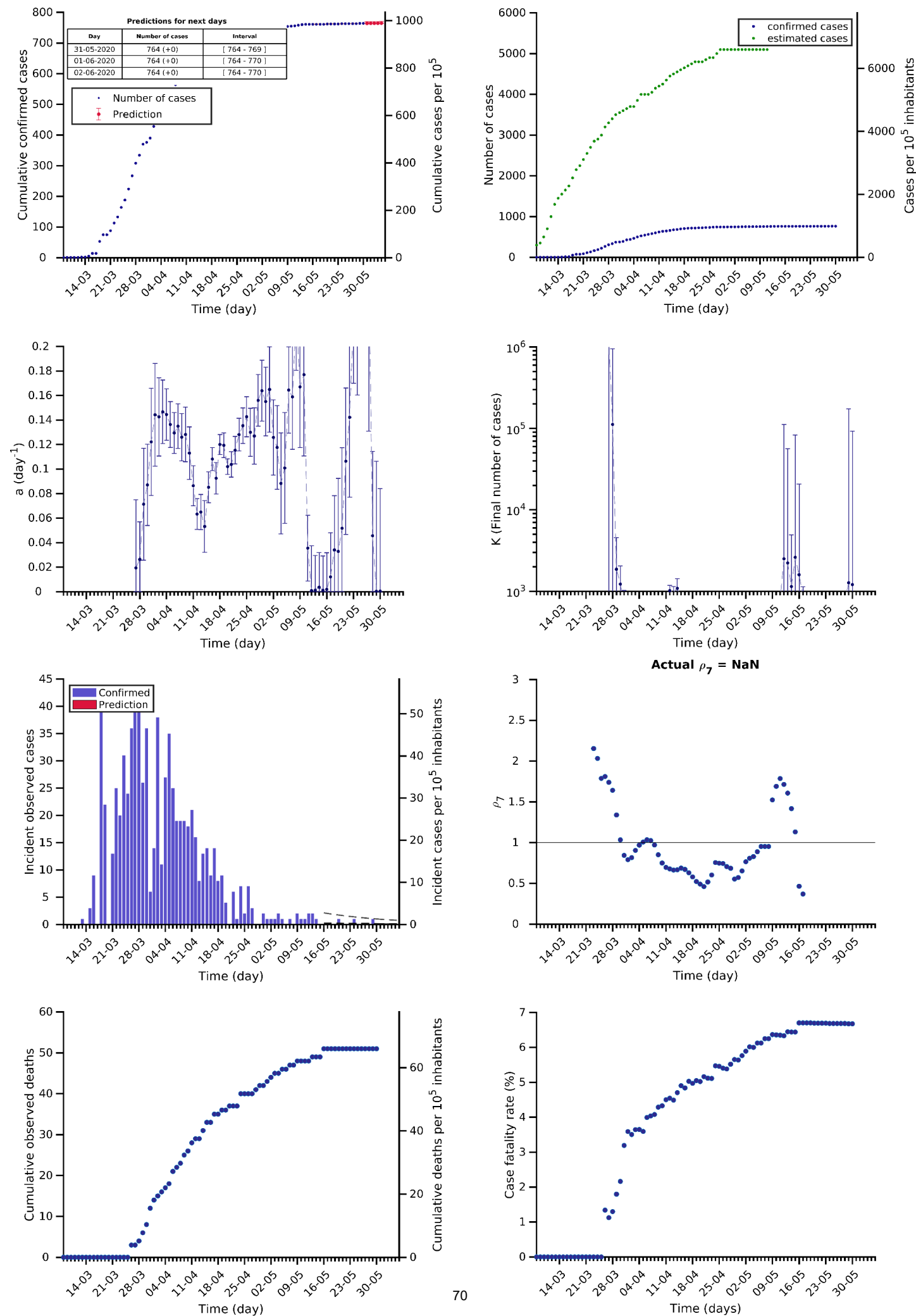
# Malaysia 30-05-2020. Population: 32.4M. Current cumulated incidence: 24/10<sup>5</sup>



# Australia 30-05-2020. Population: 25.5M. Current cumulated incidence: 28/10<sup>5</sup>



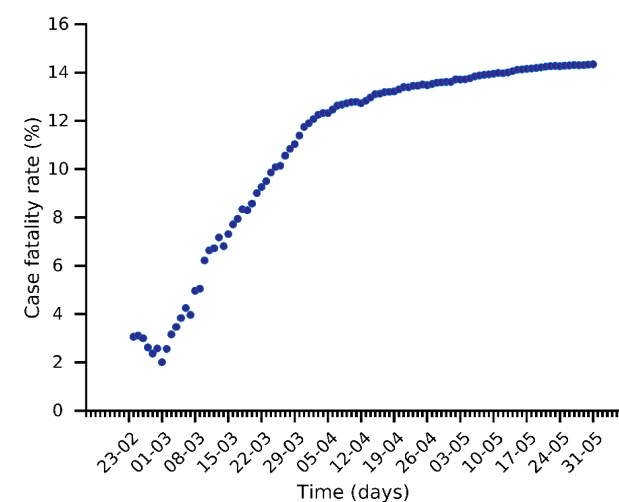
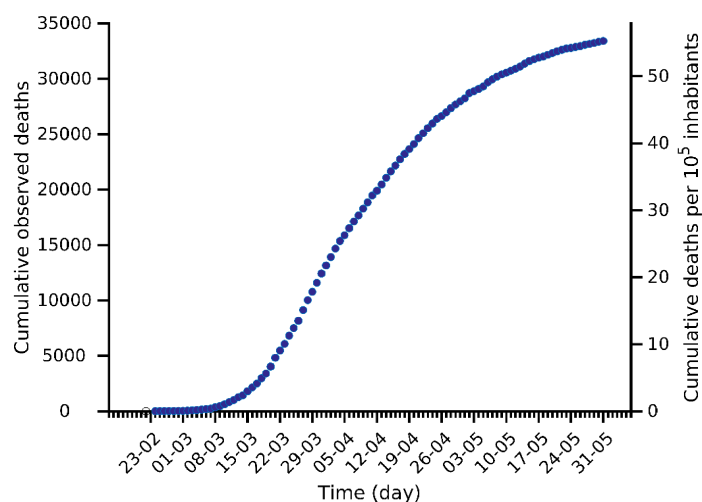
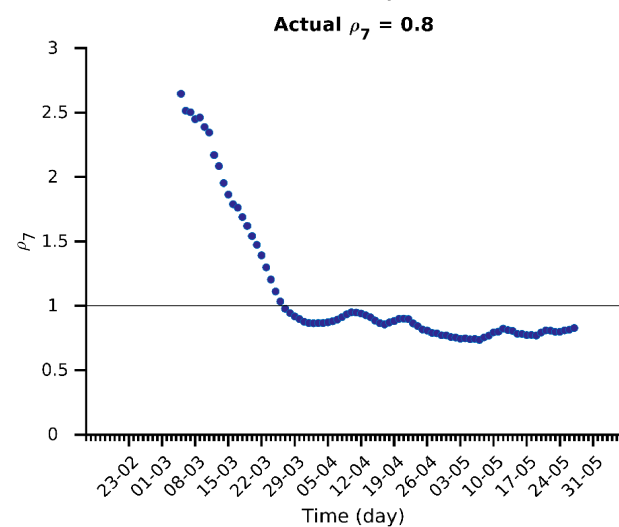
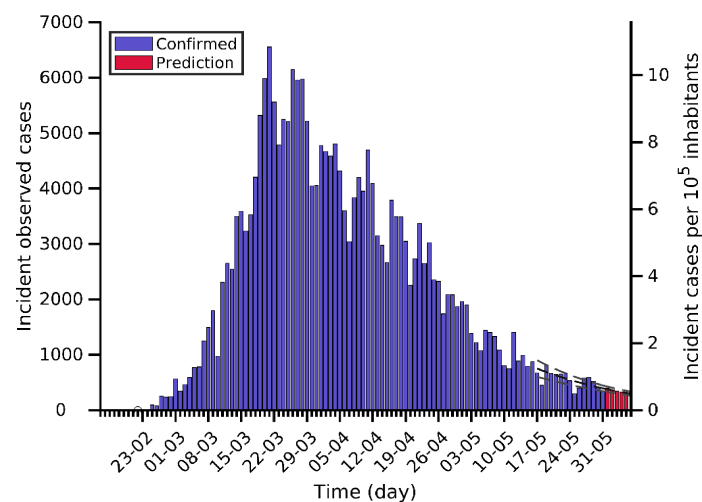
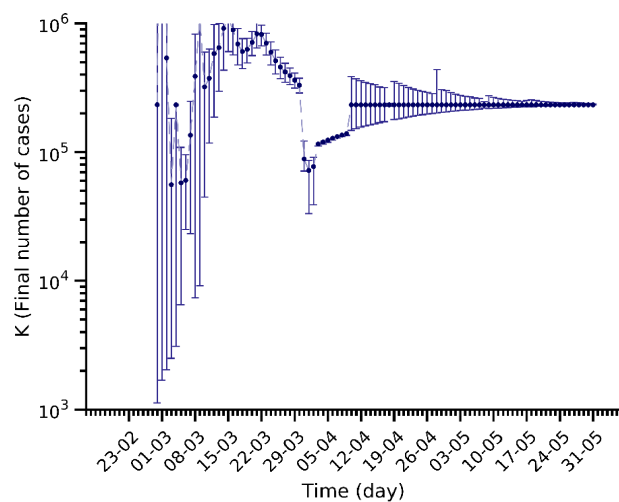
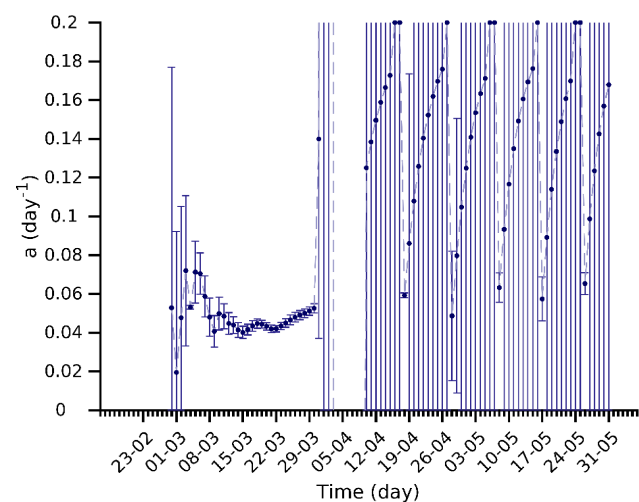
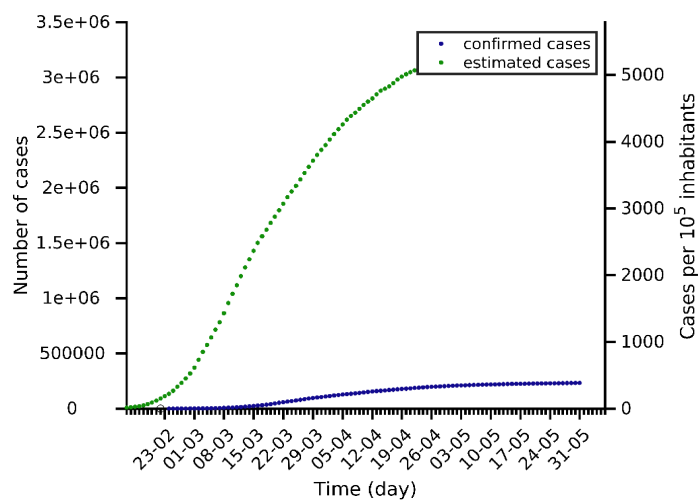
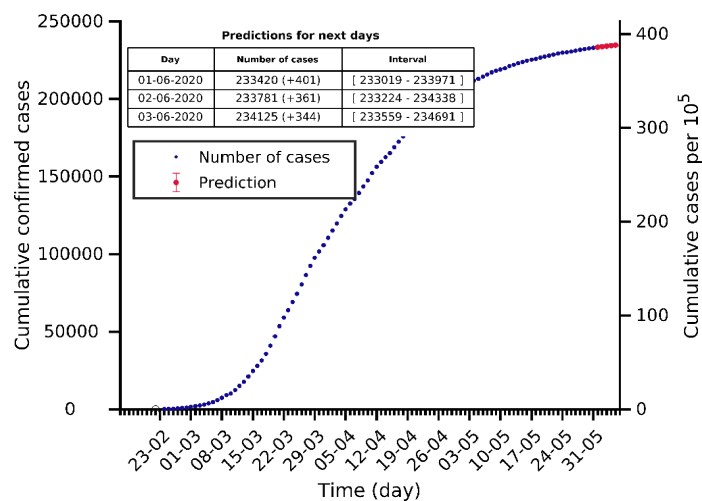
# Andorra 30-05-2020. Population: 0.1M. Current cumulated incidence: 989/10<sup>5</sup>



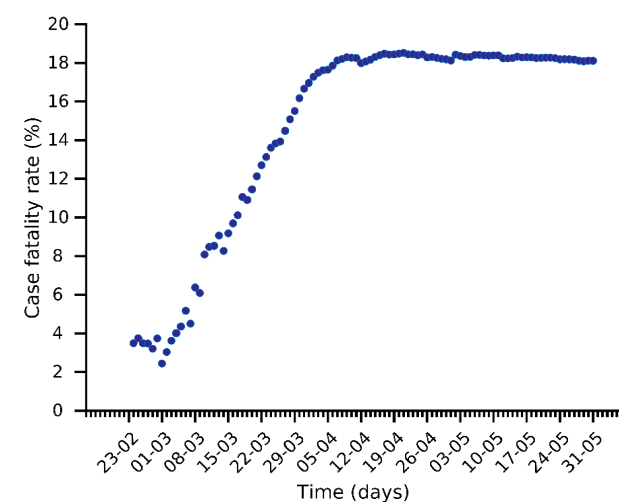
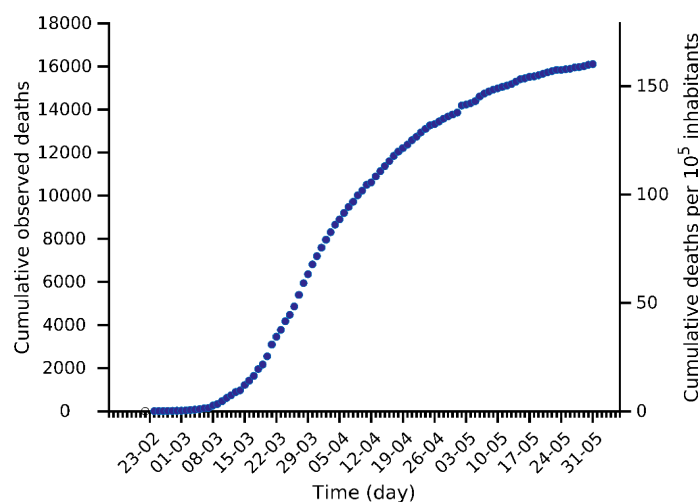
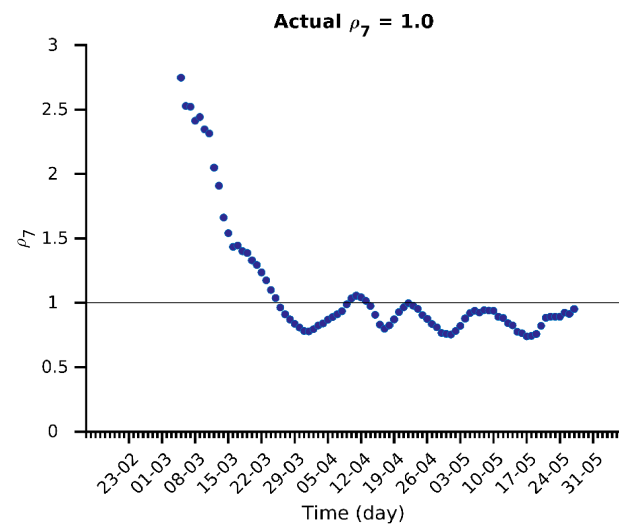
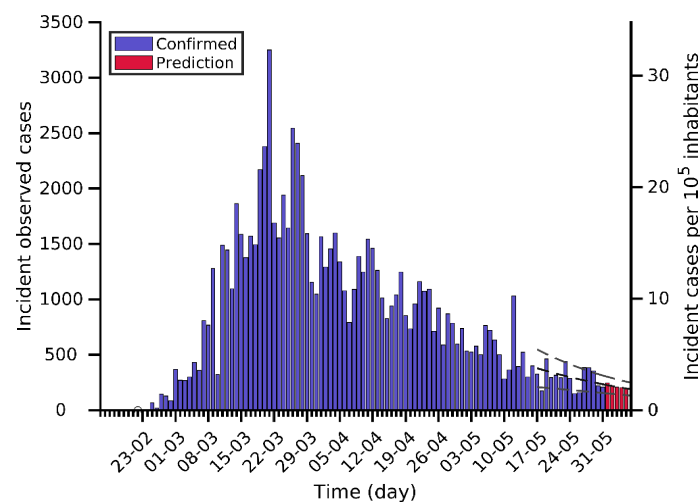
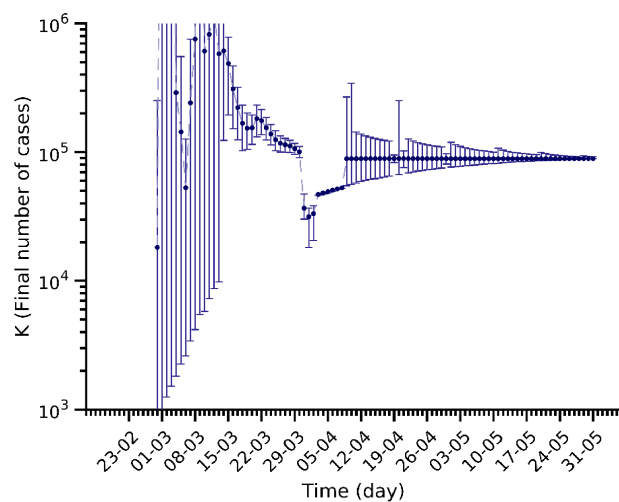
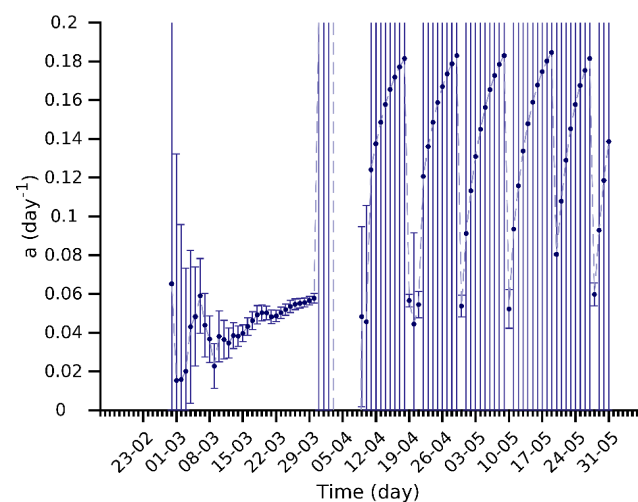
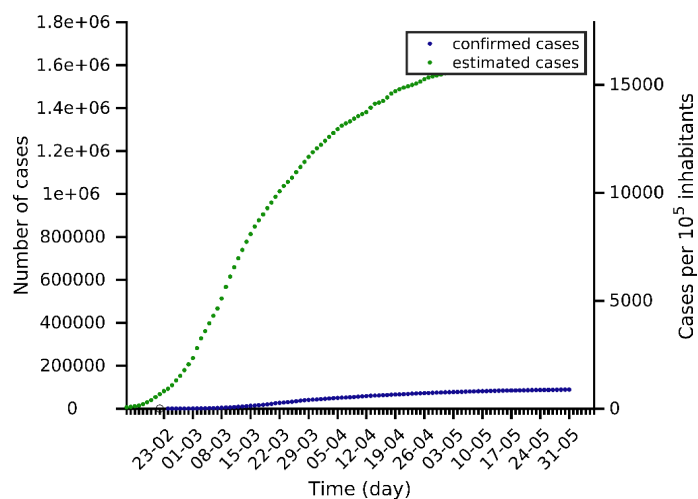
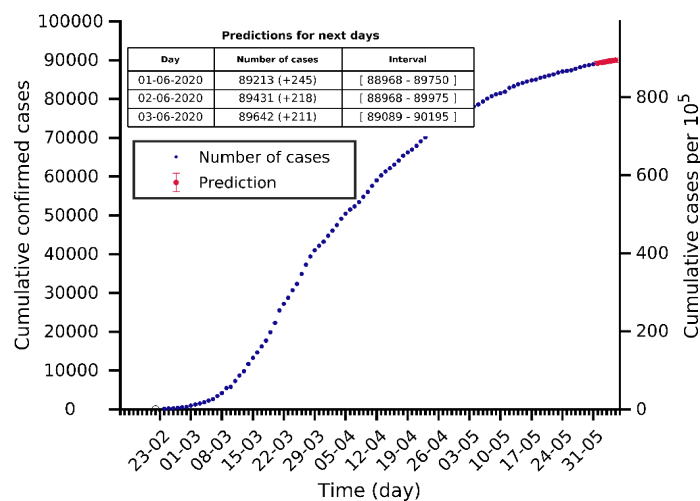
### **(3) Analysis and prediction of COVID-19 for Italy and its regions**

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

# Italy 31-05-2020. Population: 60.5M. Current cumulated incidence: 385/10<sup>5</sup>

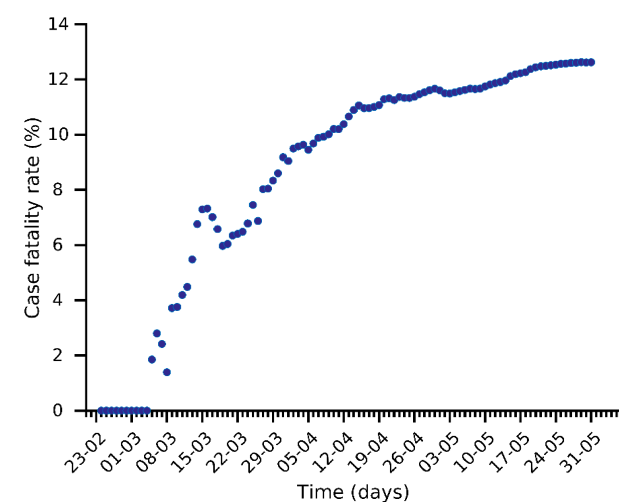
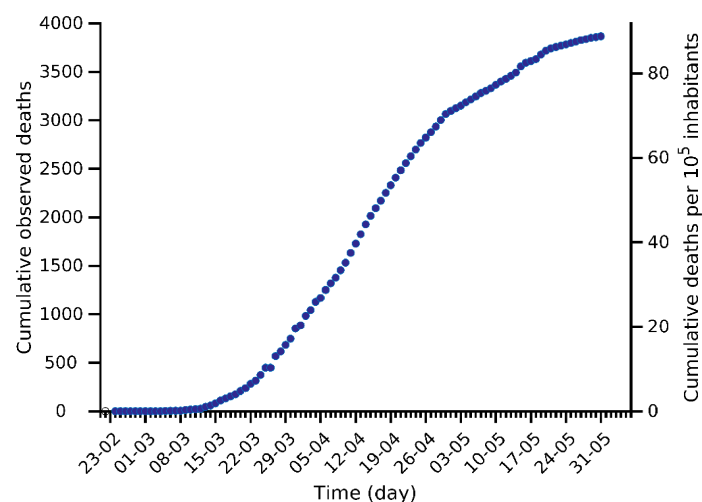
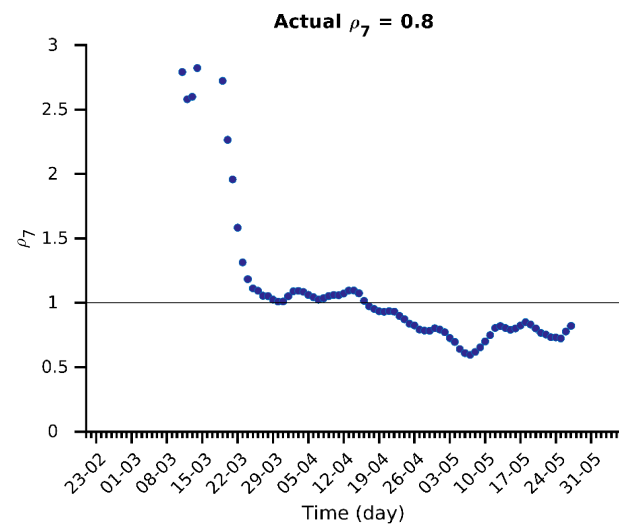
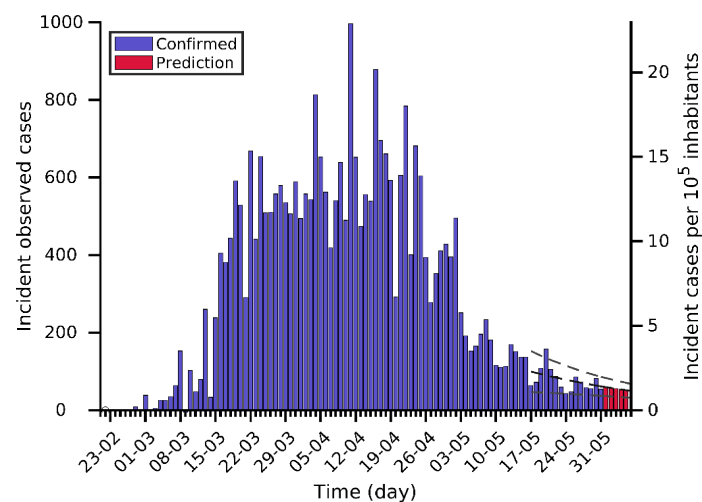
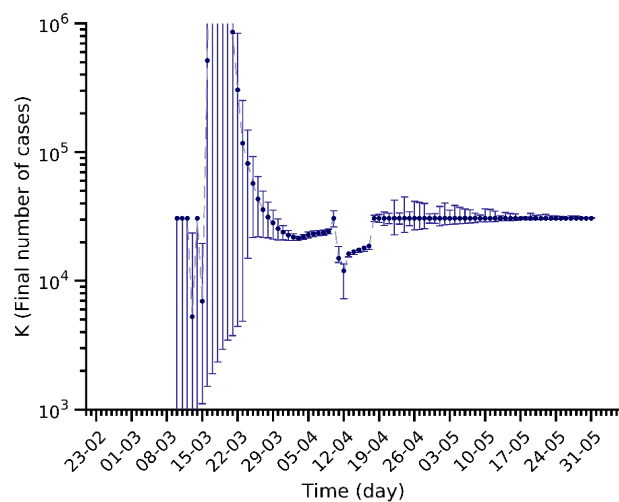
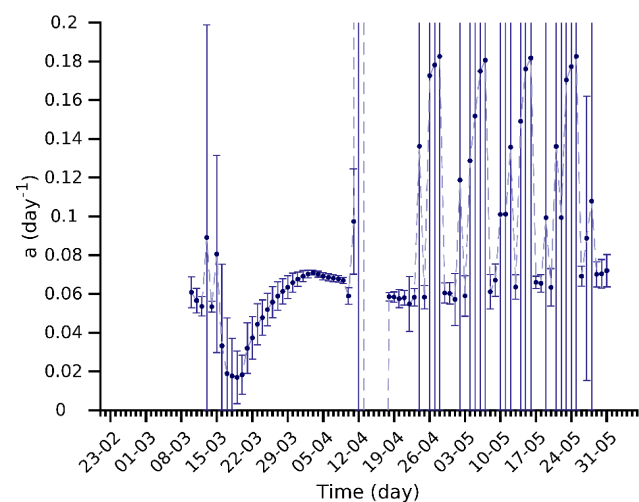
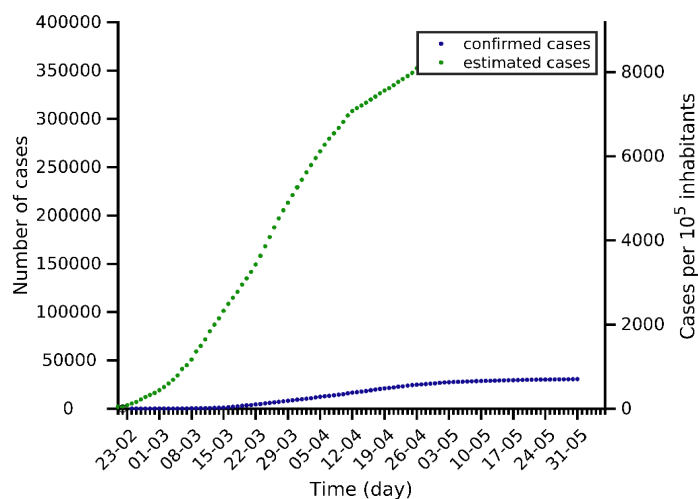
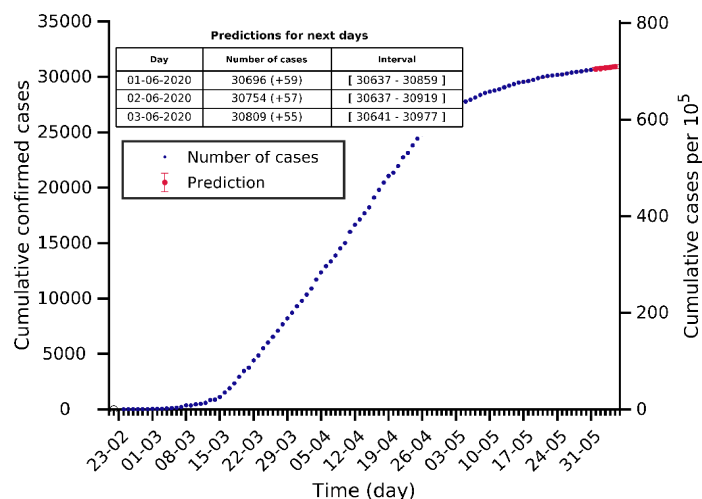


# Lombardia 31-05-2020. Population: 10.1M. Current cumulated incidence: 884/10<sup>5</sup>

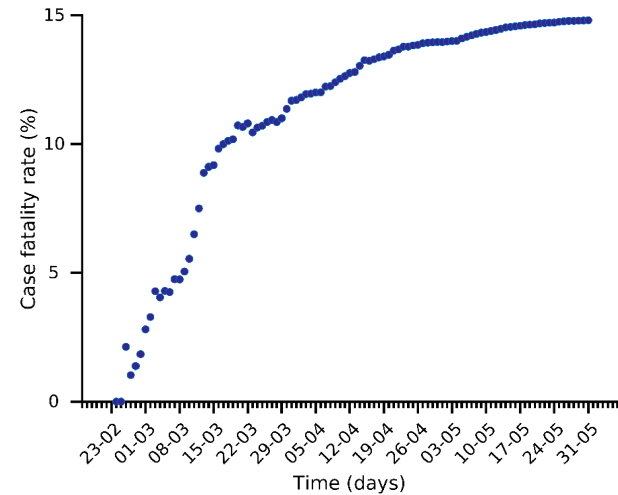
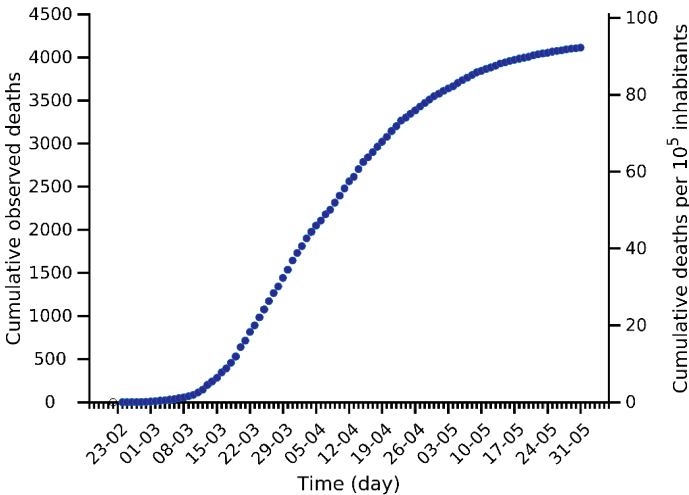
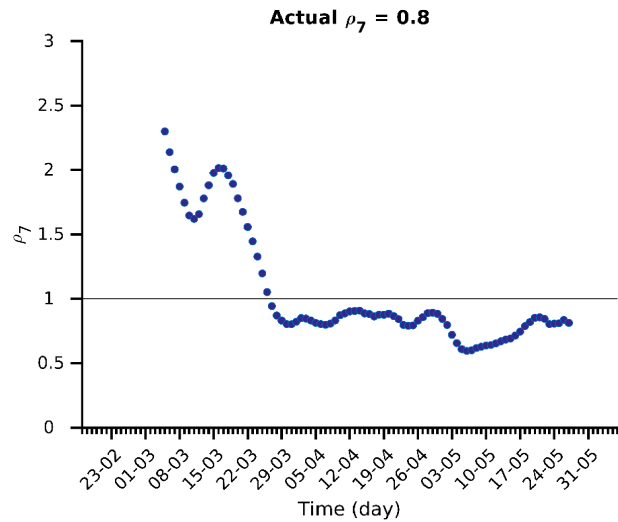
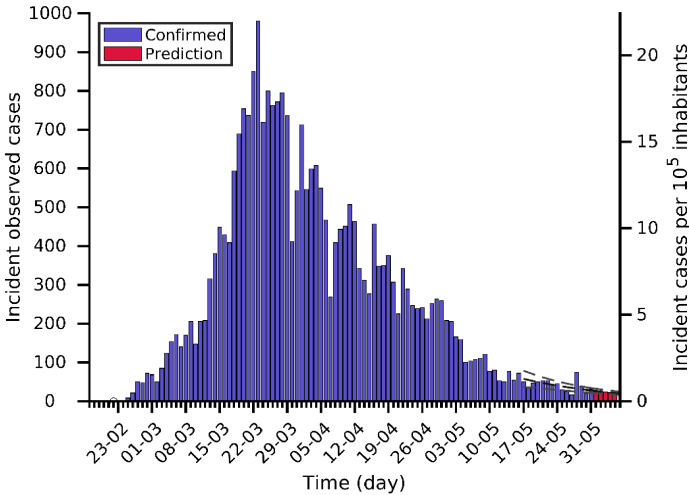
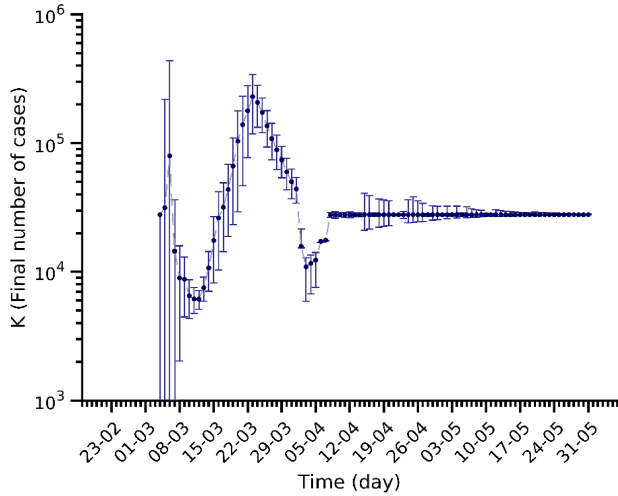
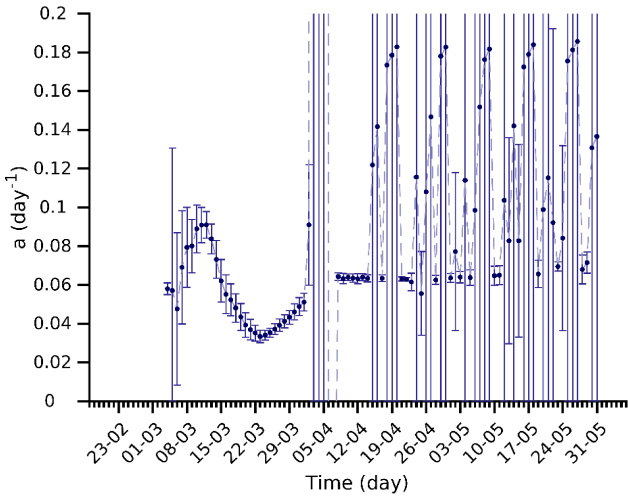
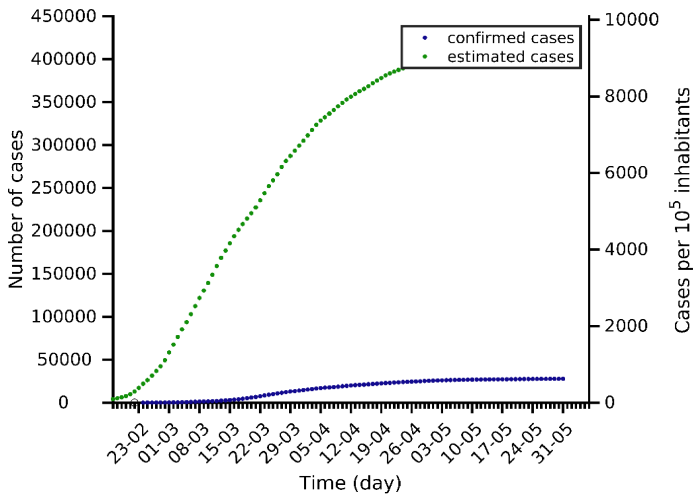
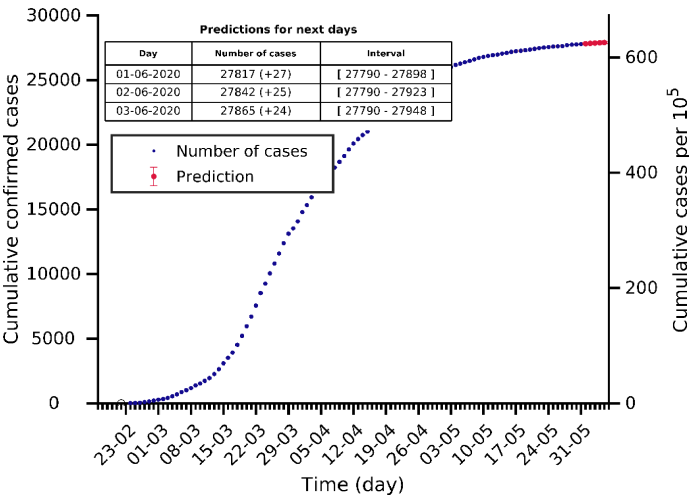




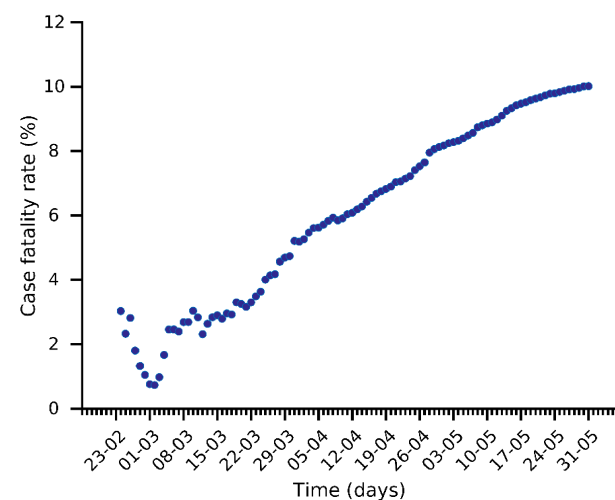
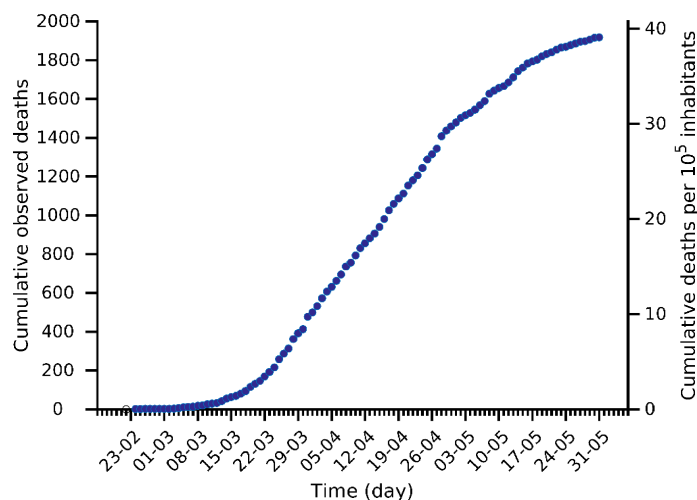
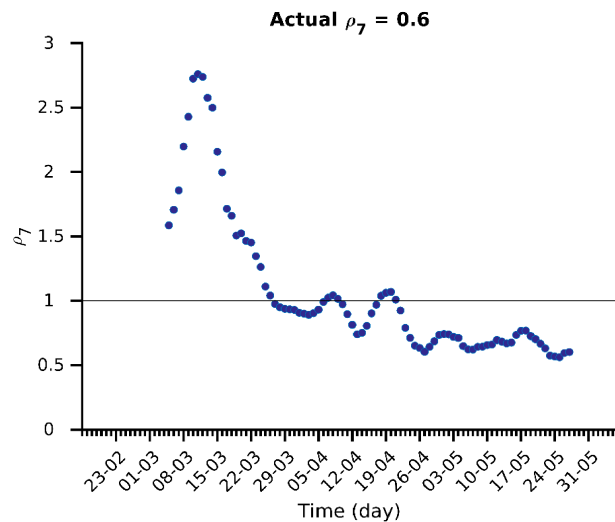
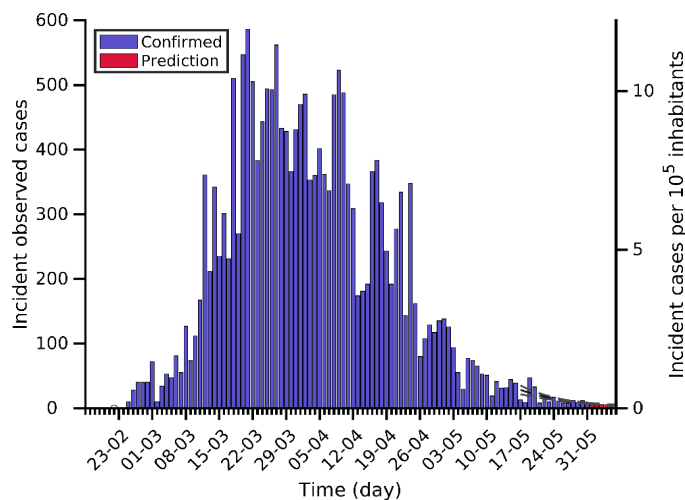
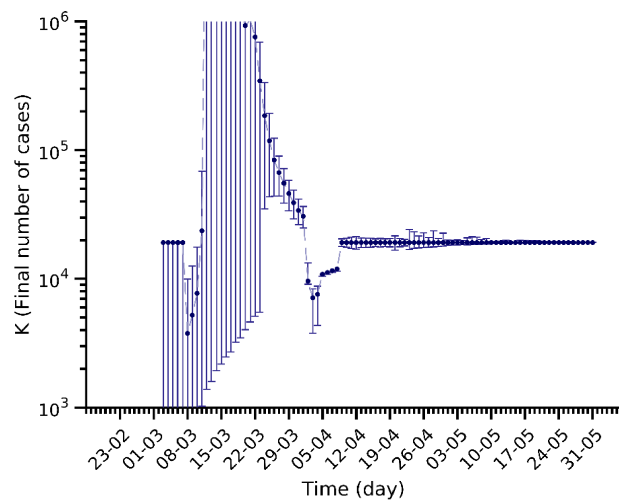
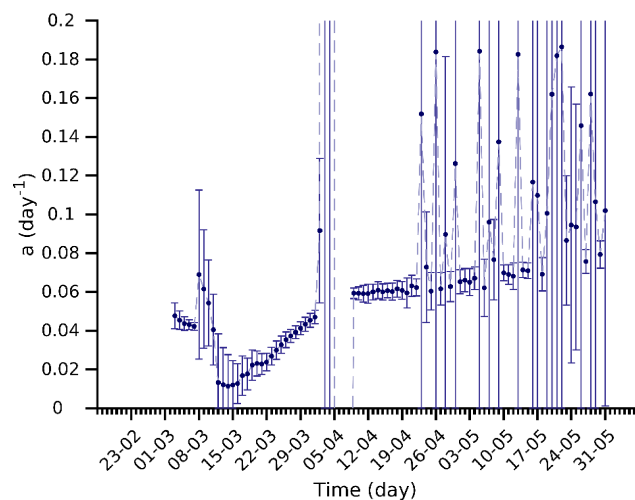
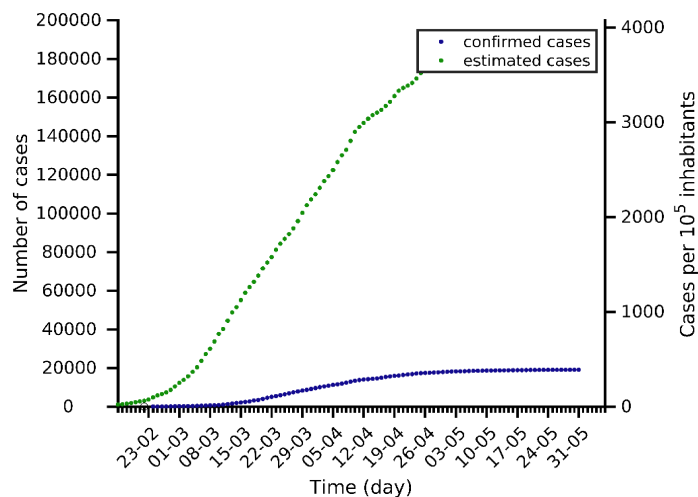
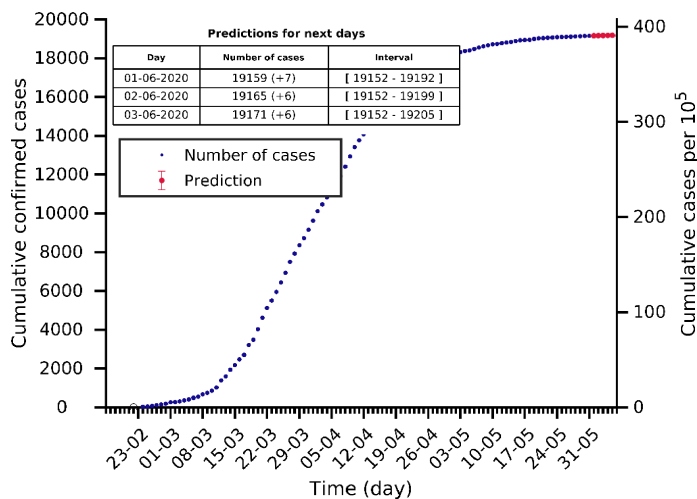
# Piemonte 31-05-2020. Population: 4.4M. Current cumulated incidence: 703/10<sup>5</sup>



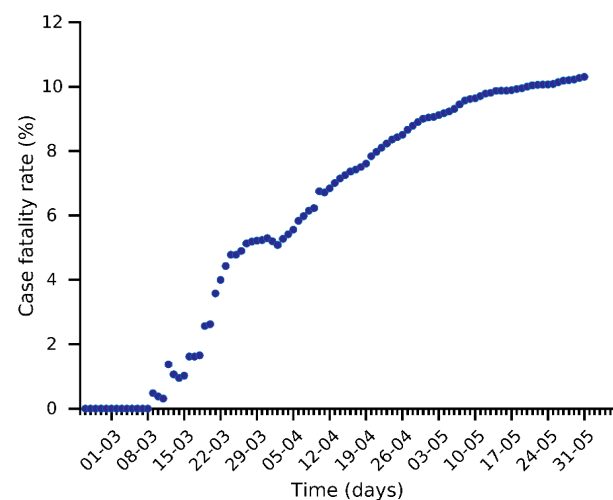
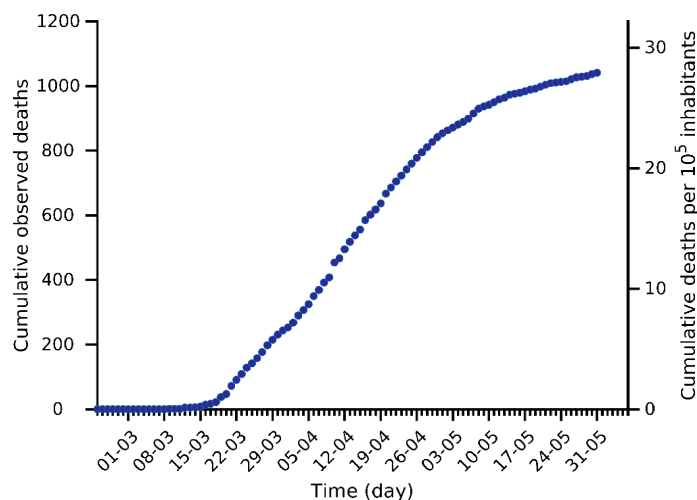
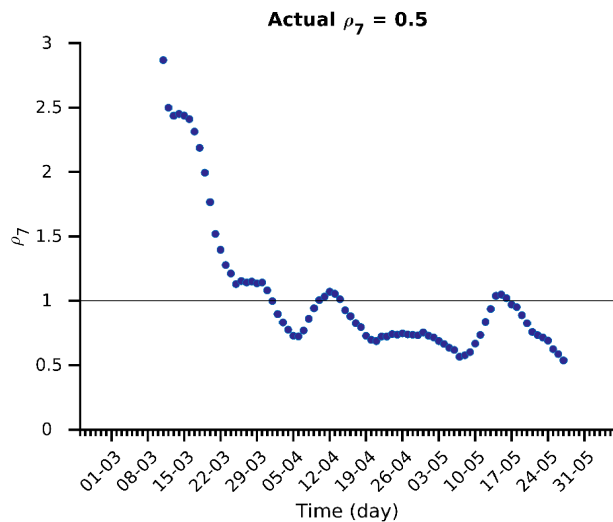
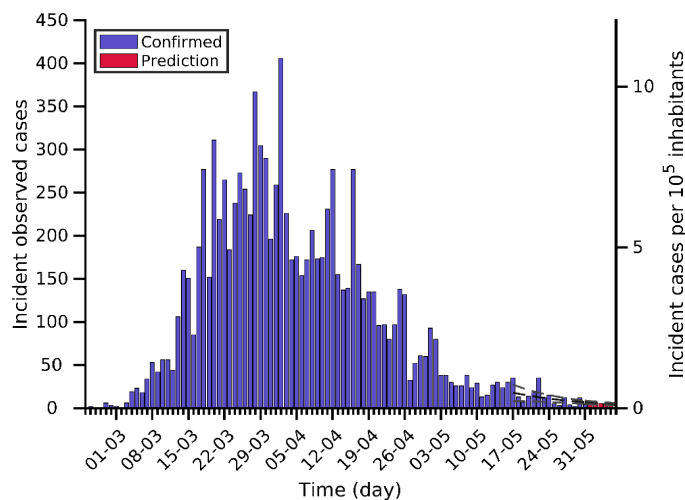
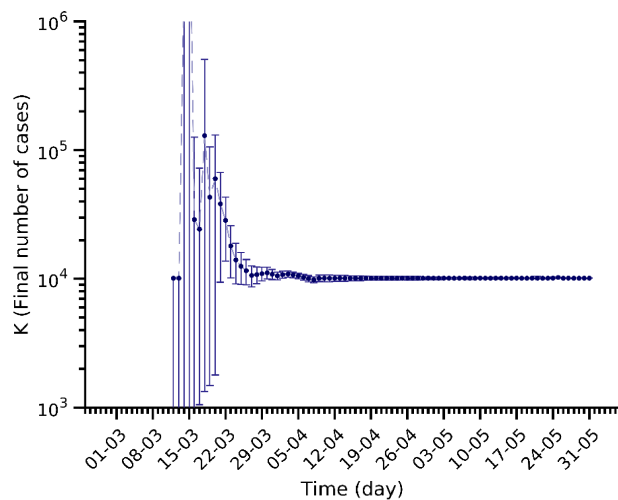
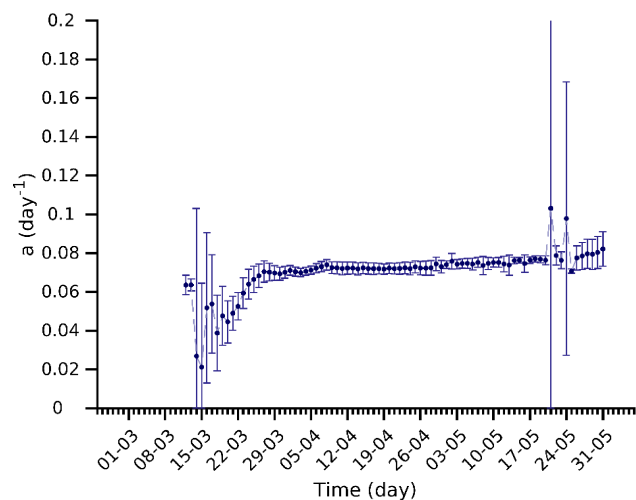
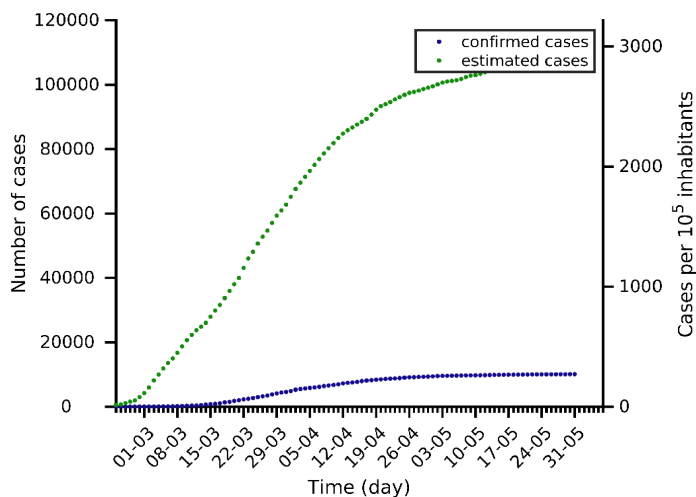
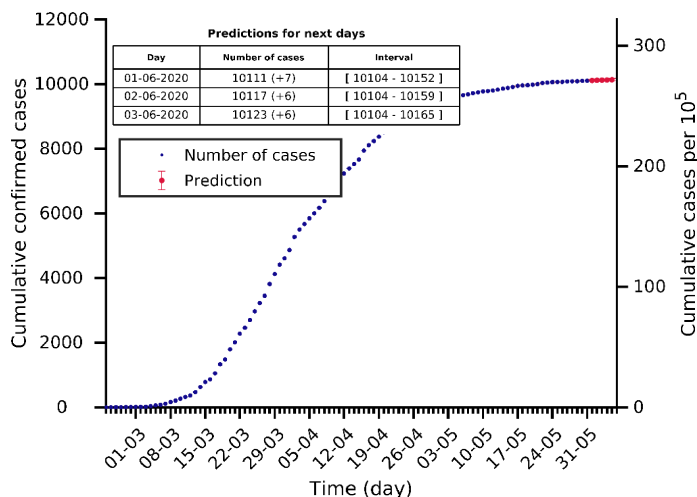
Emilia Romagna 31-05-2020. Population: 4.5M. Current cumulated incidence: 623/100000



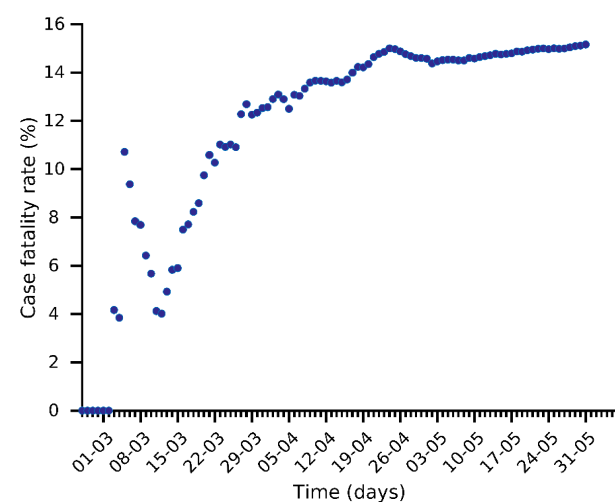
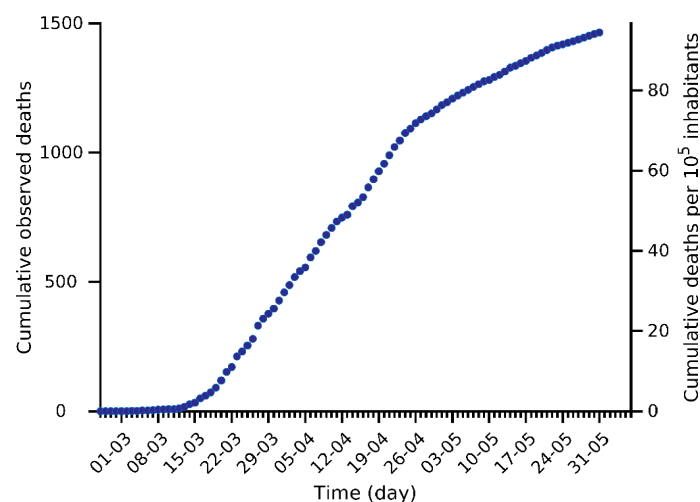
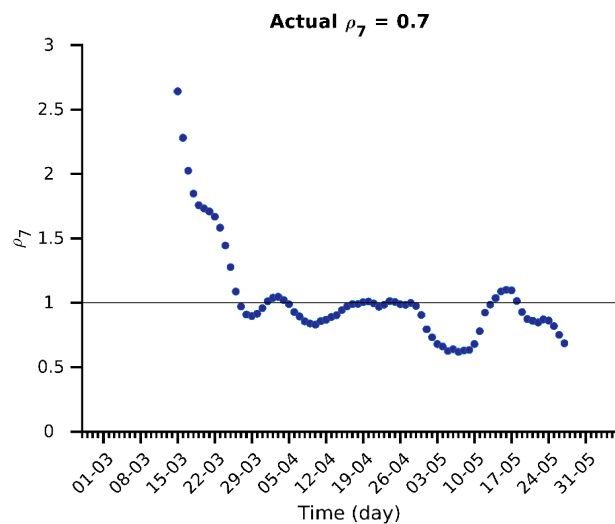
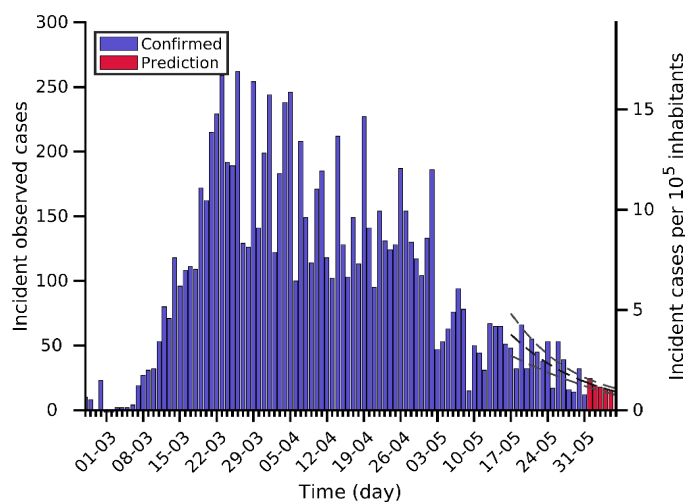
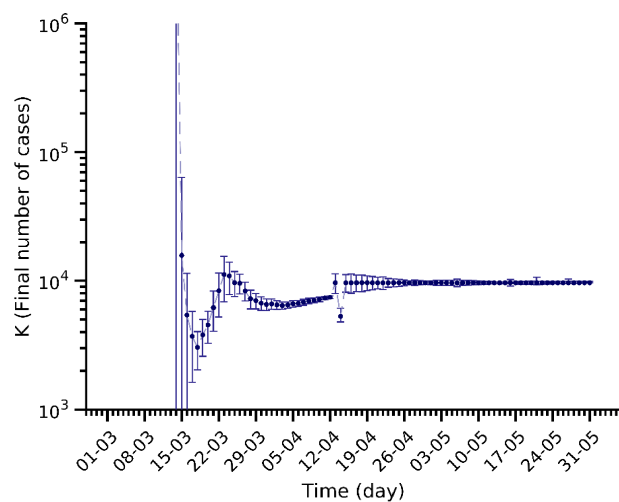
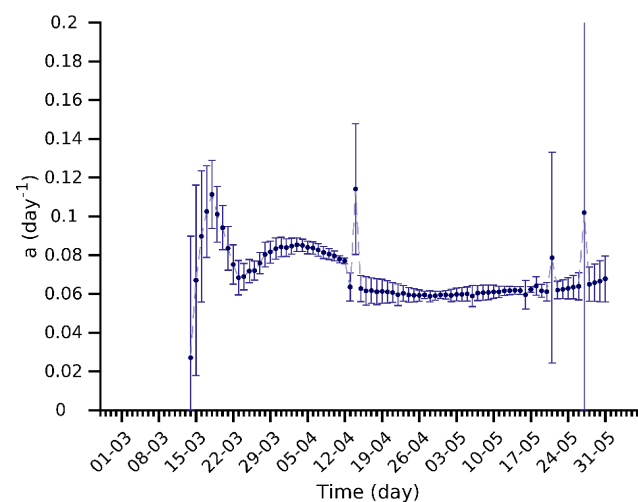
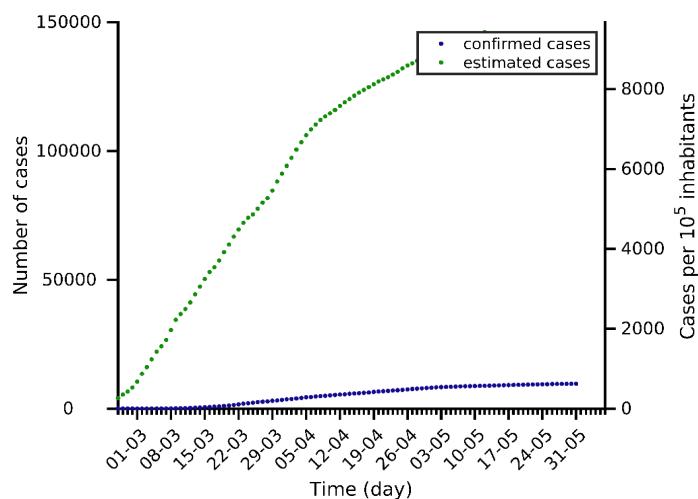
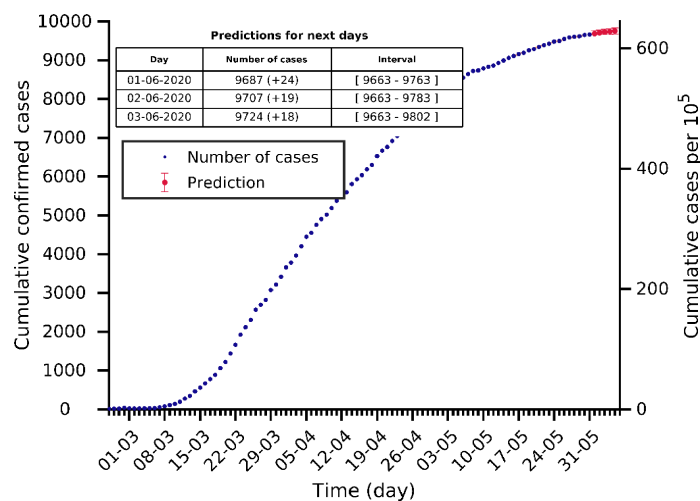
# Veneto 31-05-2020. Population: 4.9M. Current cumulated incidence: 390/10<sup>5</sup>



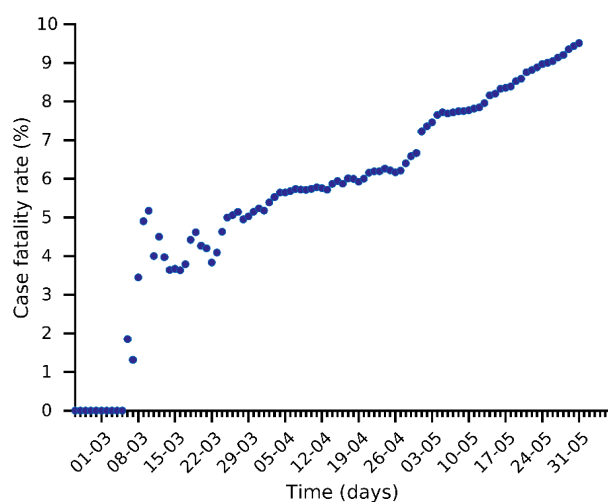
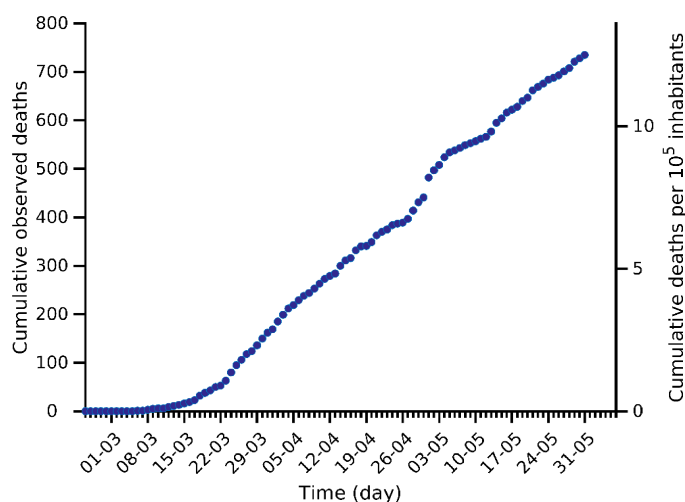
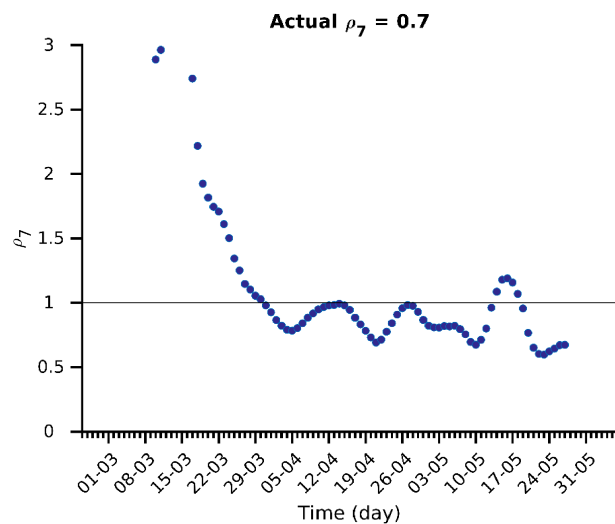
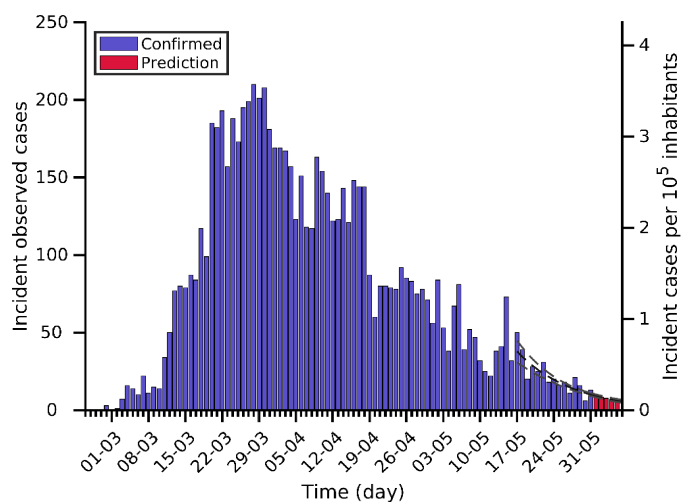
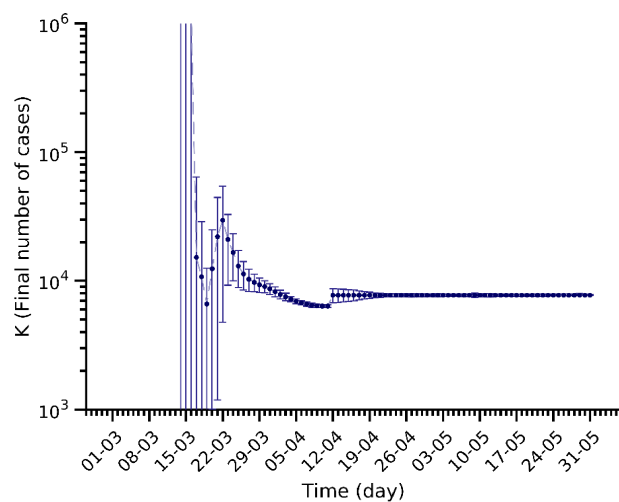
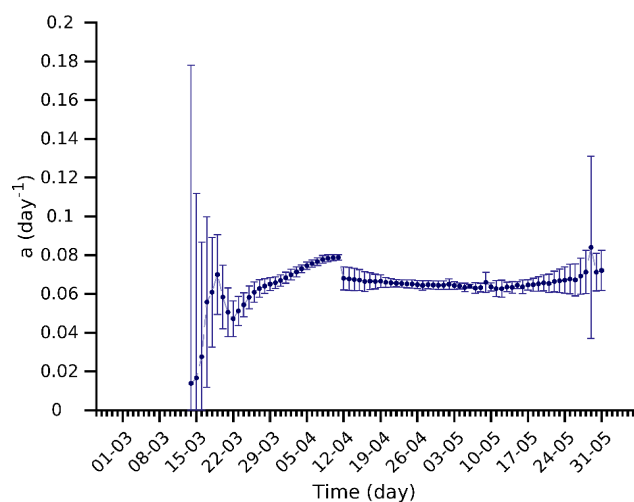
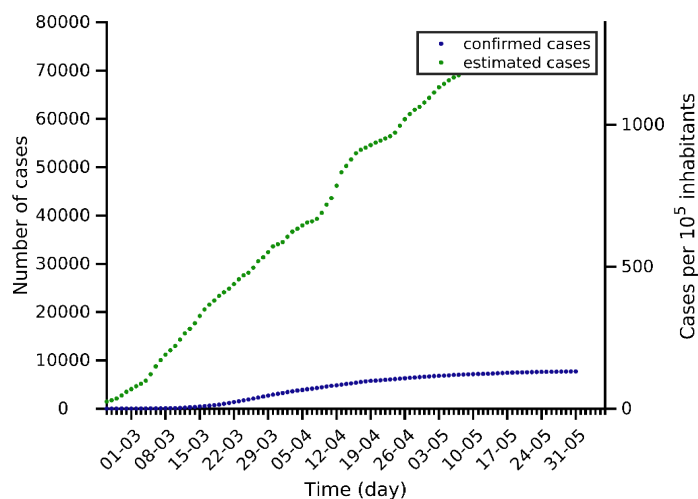
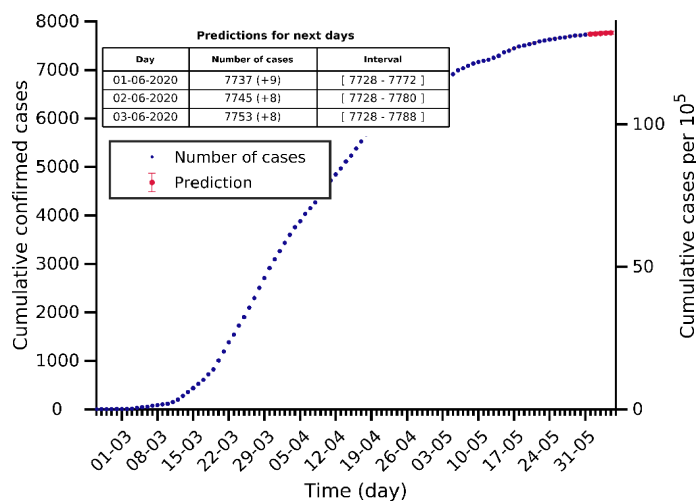
# Toscana 31-05-2020. Population: 3.7M. Current cumulated incidence: 271/10<sup>5</sup>



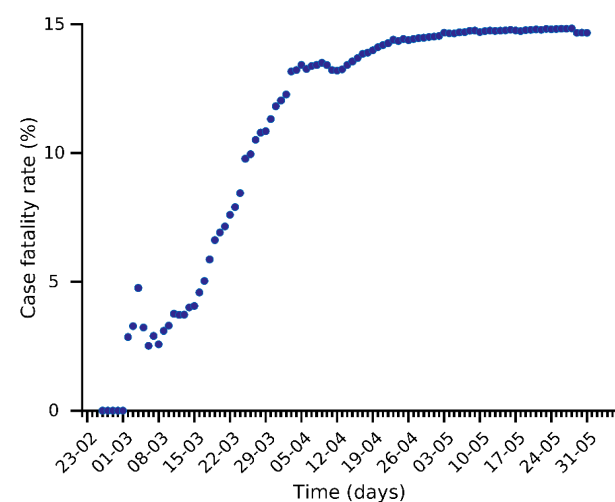
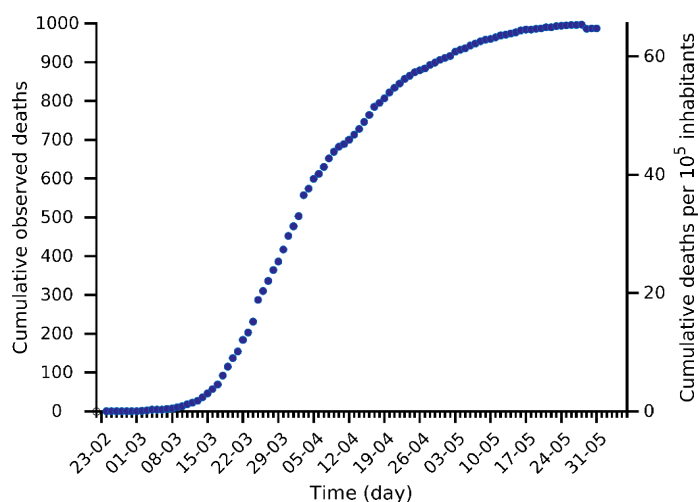
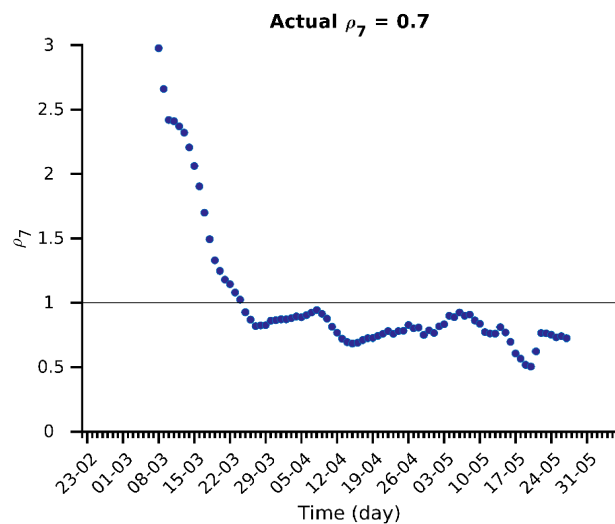
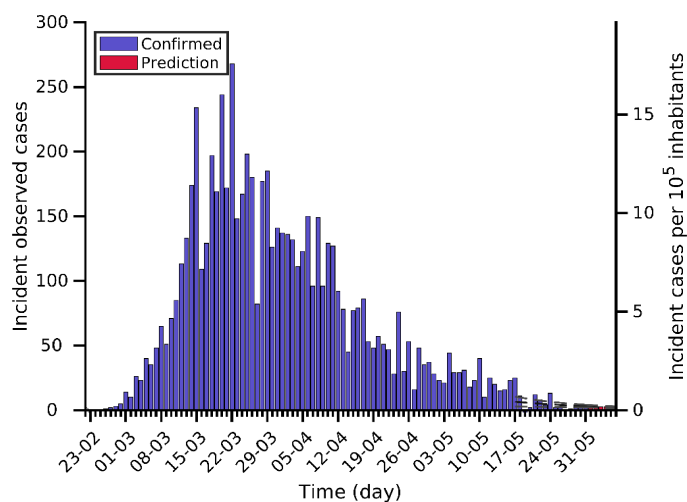
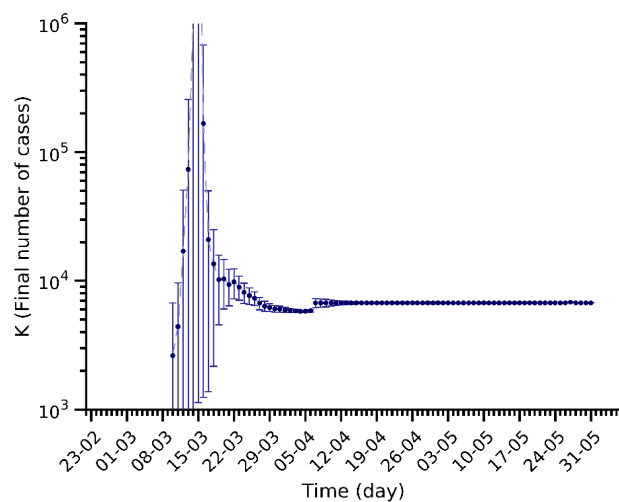
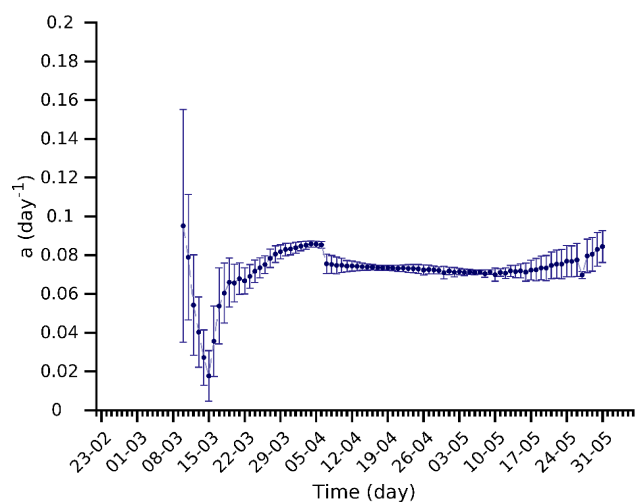
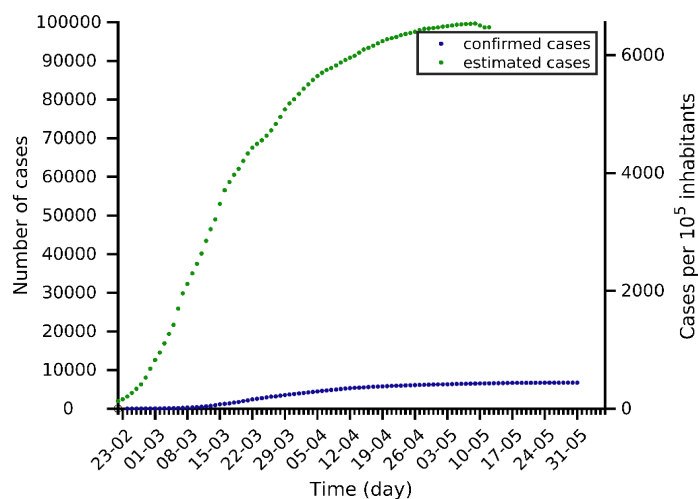
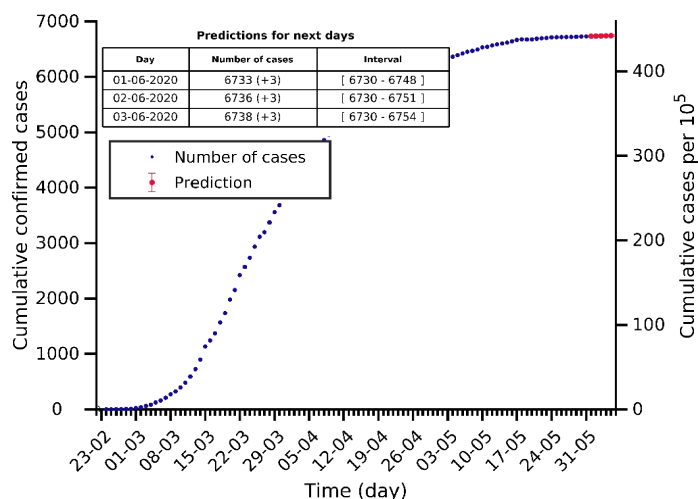
# Liguria 31-05-2020. Population: 1.6M. Current cumulated incidence: 623/10<sup>5</sup>



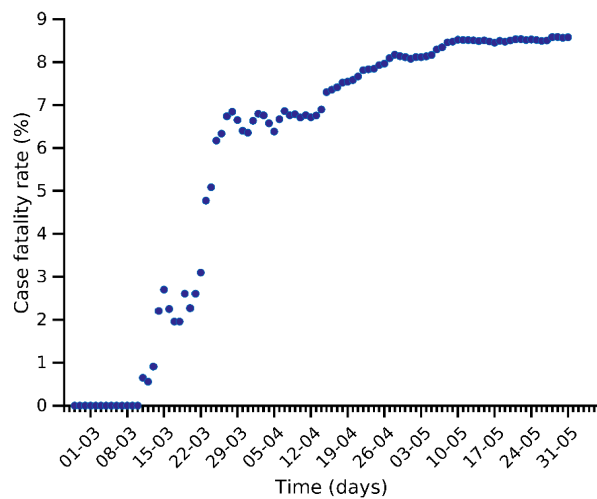
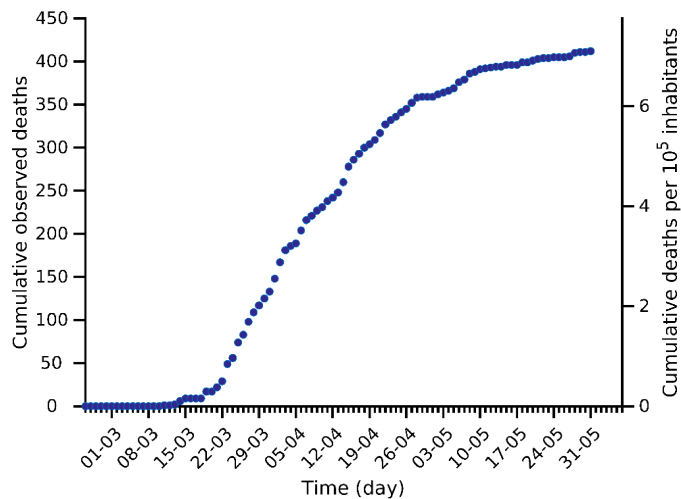
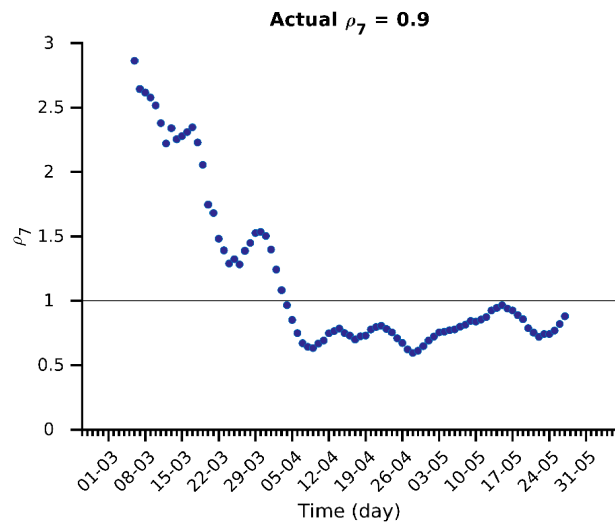
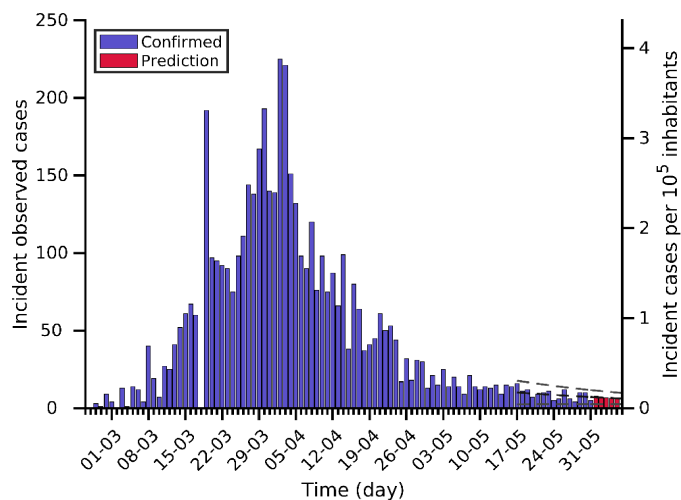
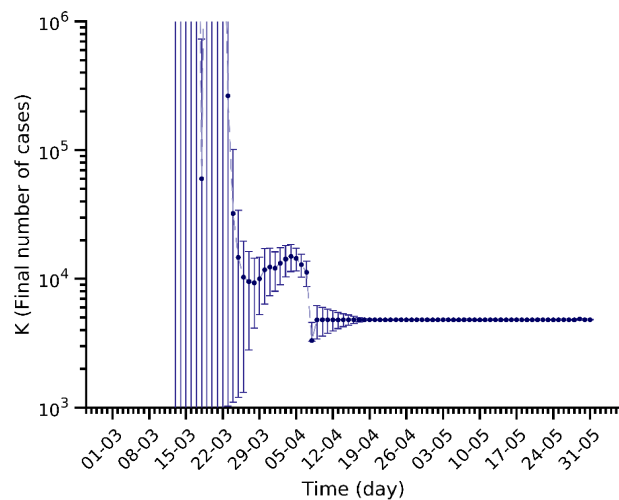
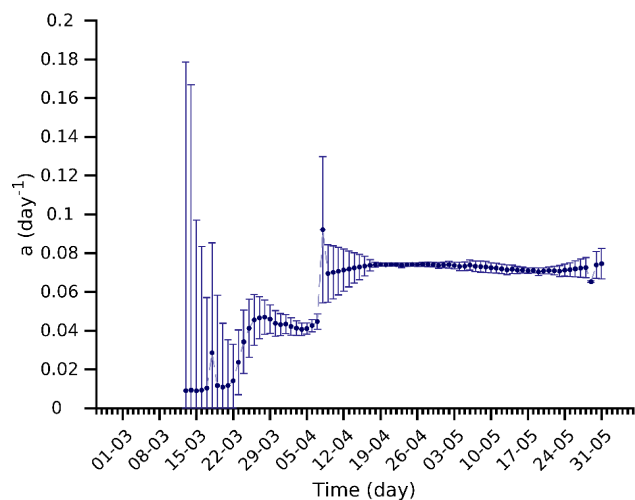
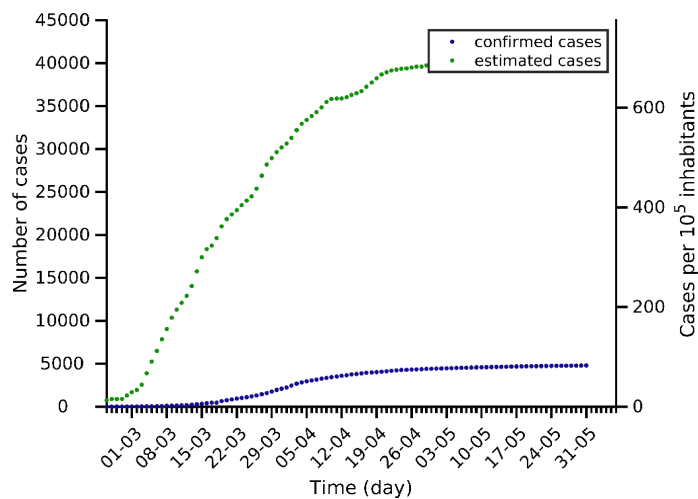
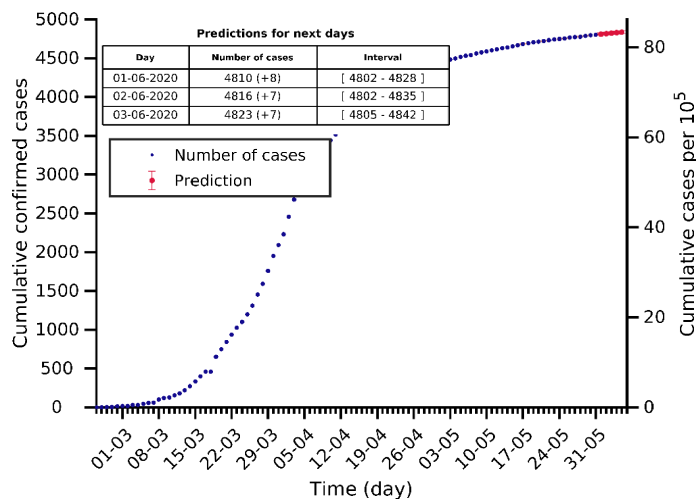
# Lazio 31-05-2020. Population: 5.9M. Current cumulated incidence: 131/10<sup>5</sup>



# **Marche 31-05-2020. Population: 1.5M. Current cumulated incidence: 441/10<sup>5</sup>**

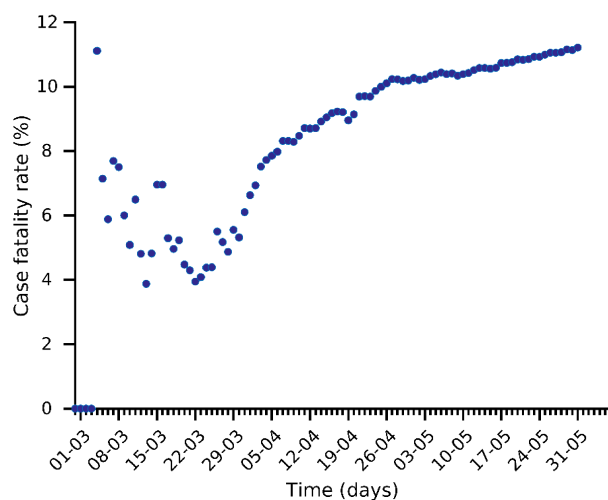
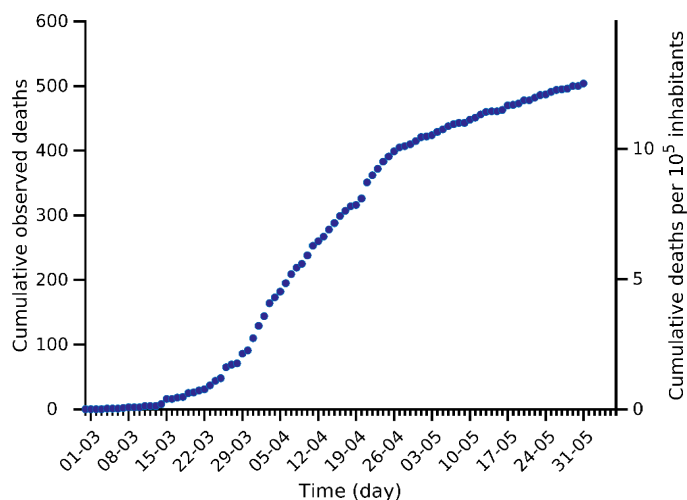
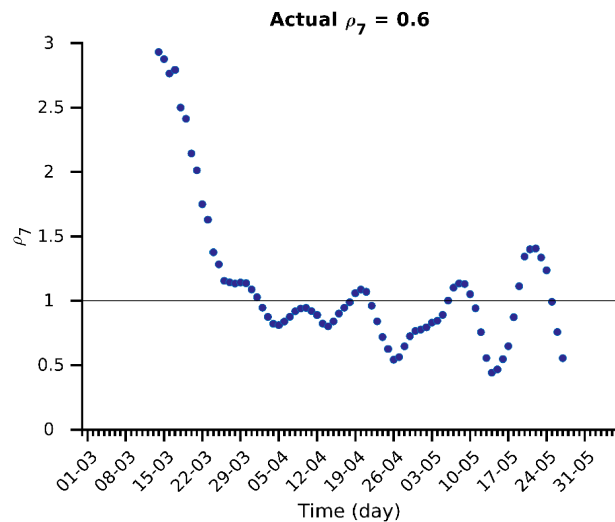
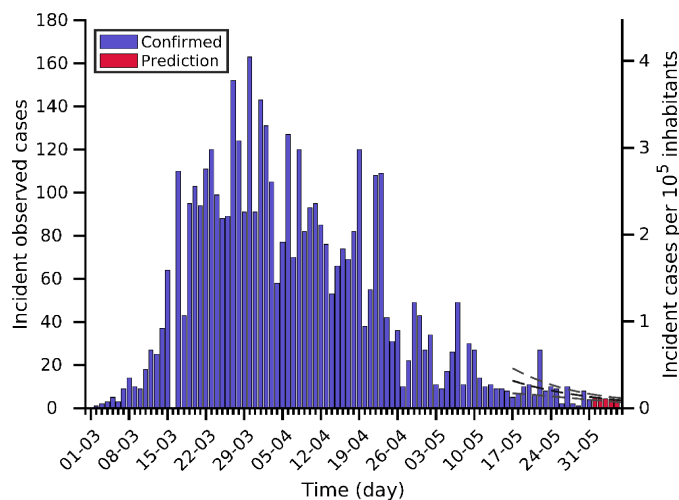
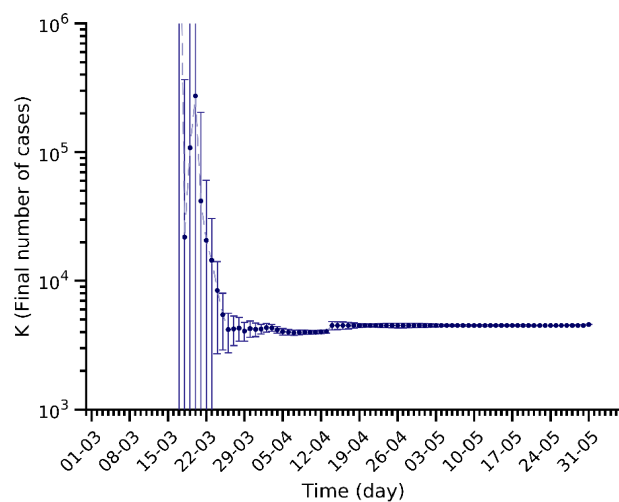
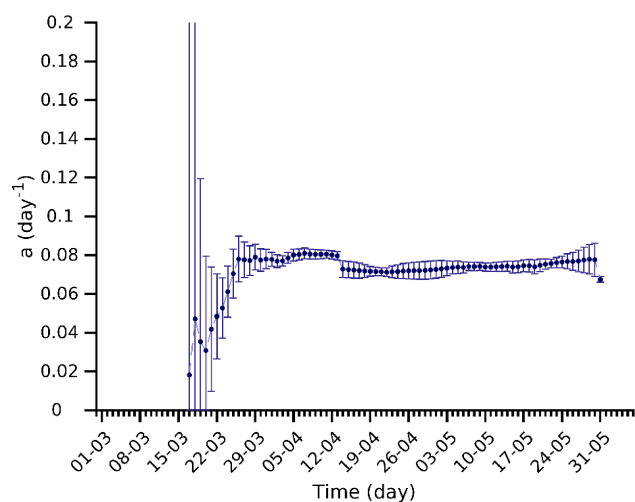
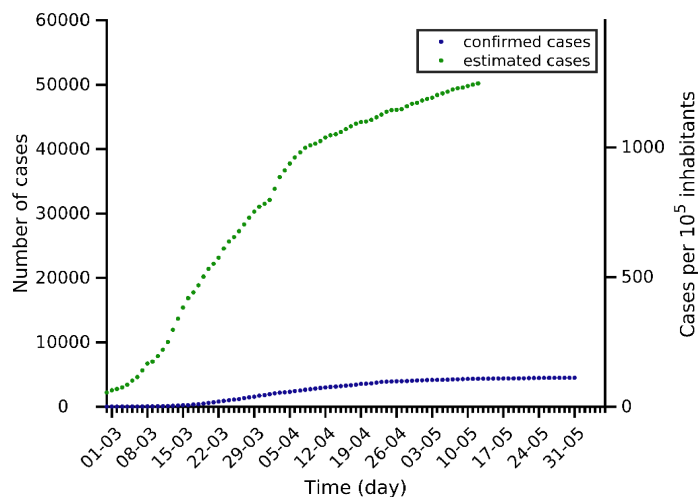
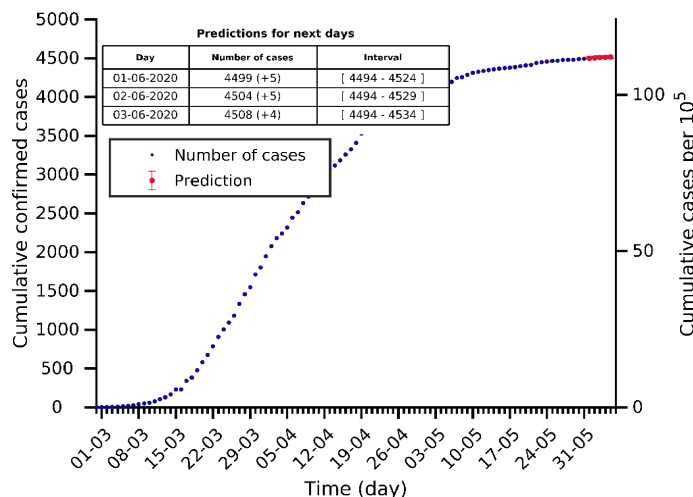


# Campania 31-05-2020. Population: 5.8M. Current cumulated incidence: 83/10<sup>5</sup>

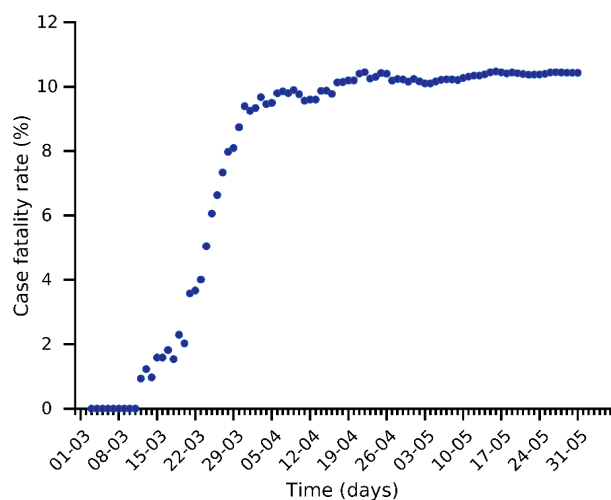
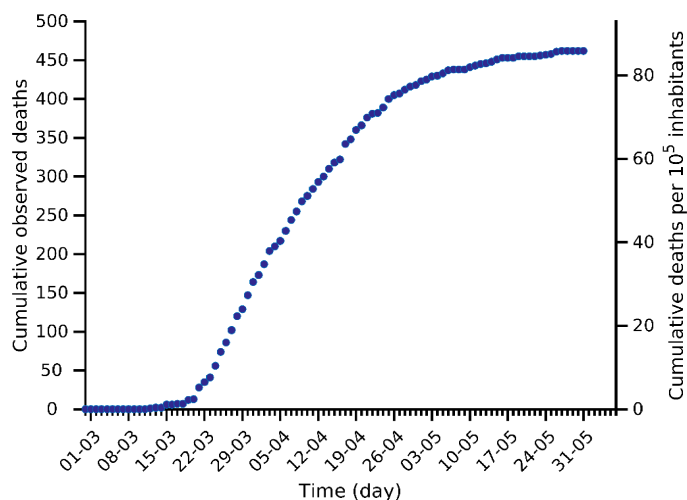
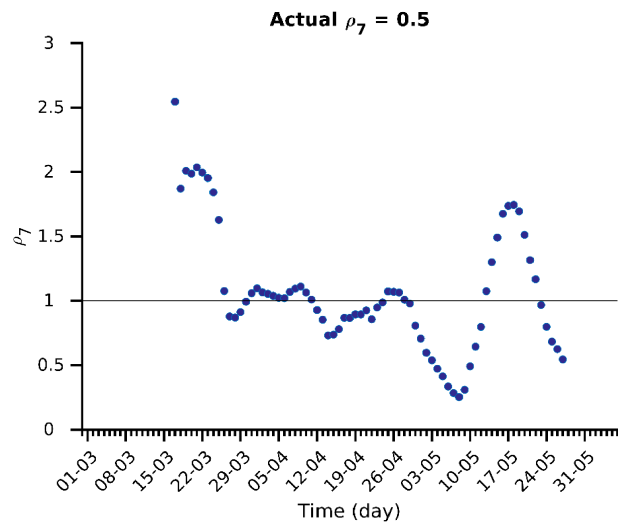
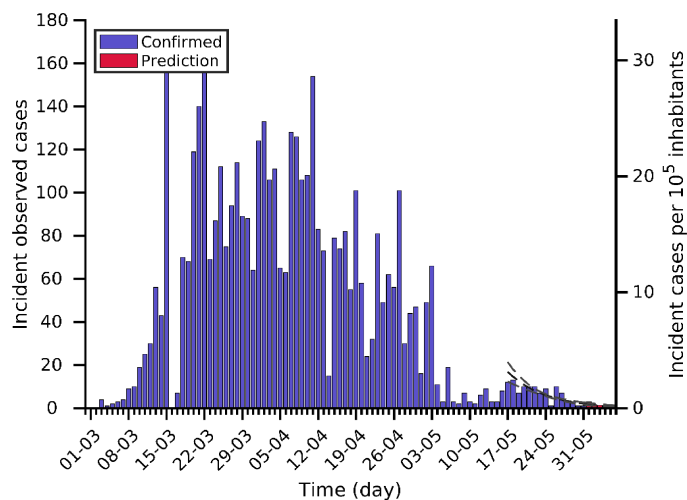
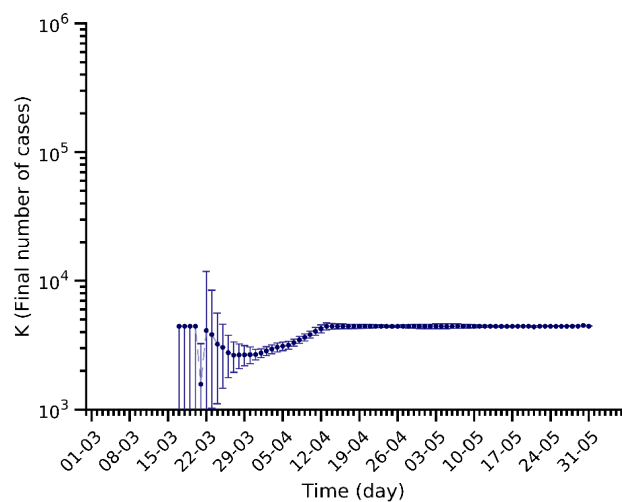
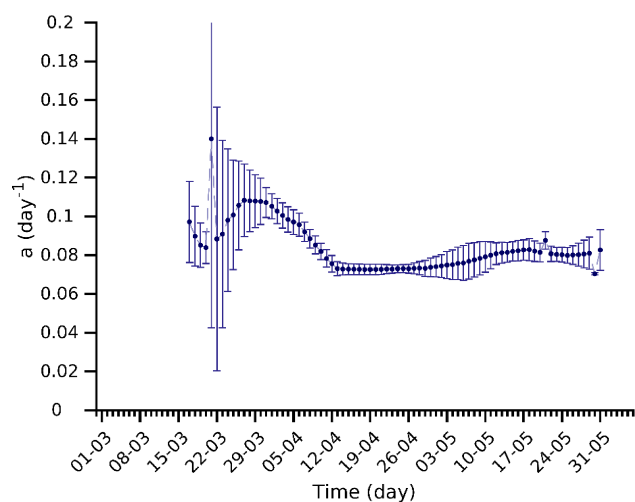
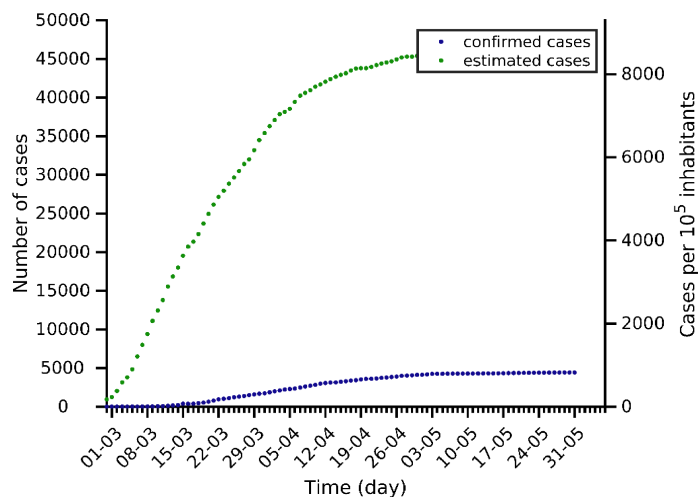
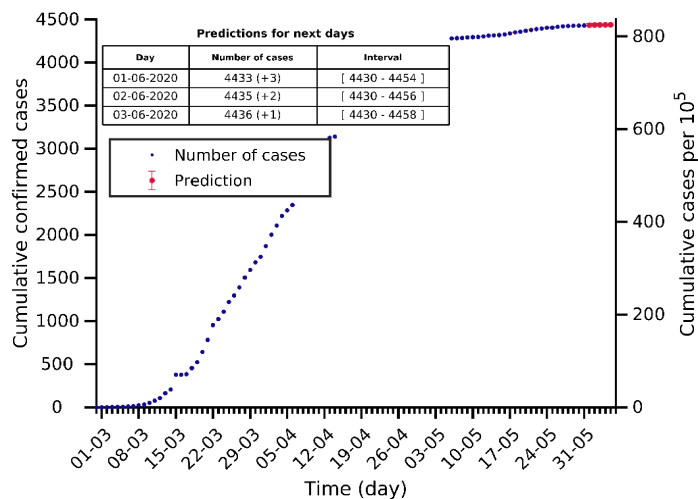




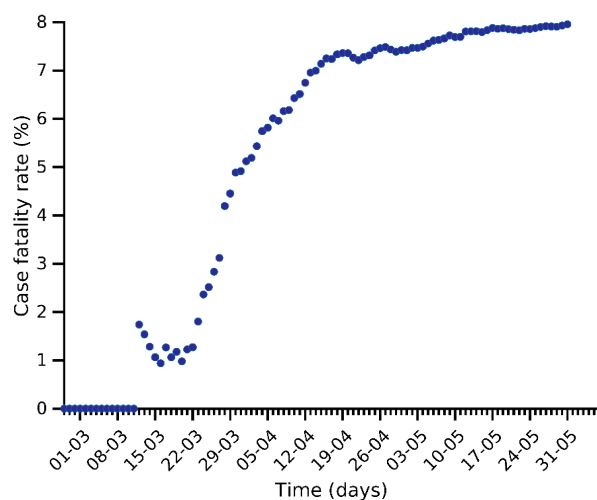
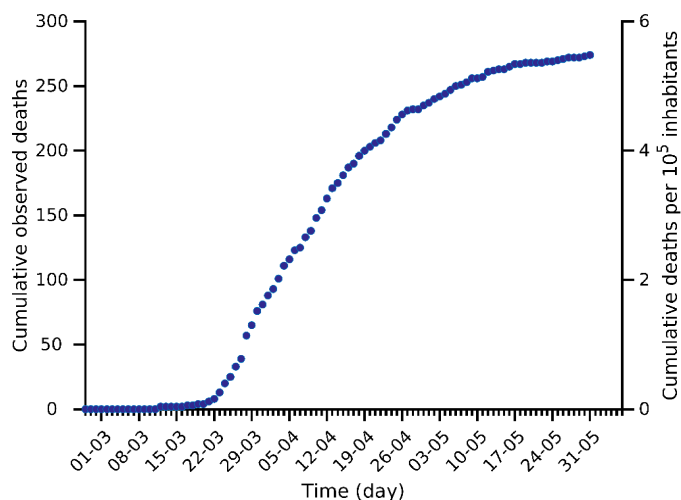
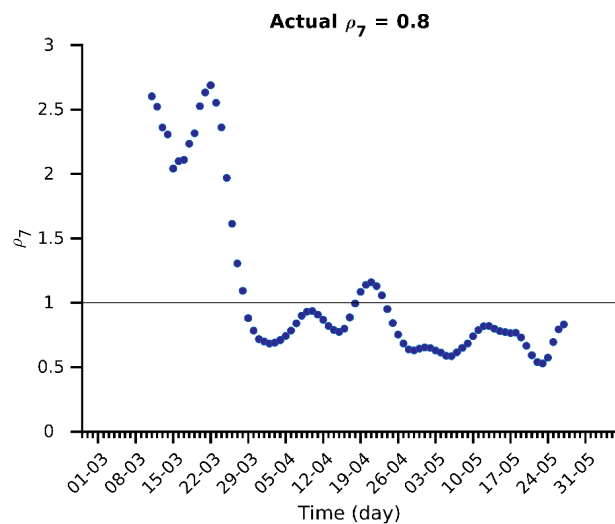
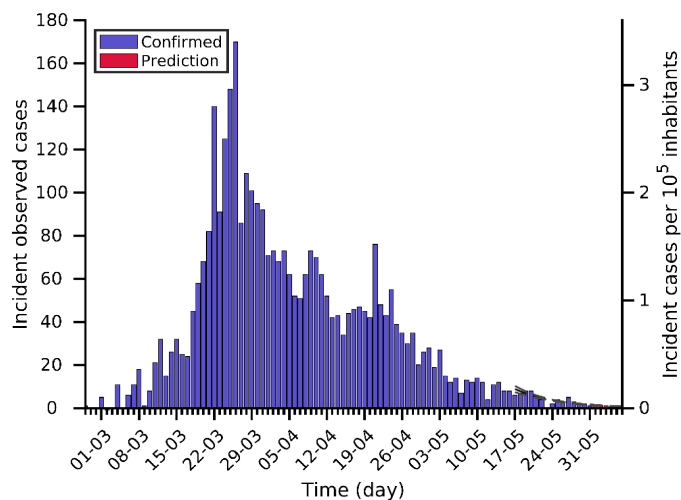
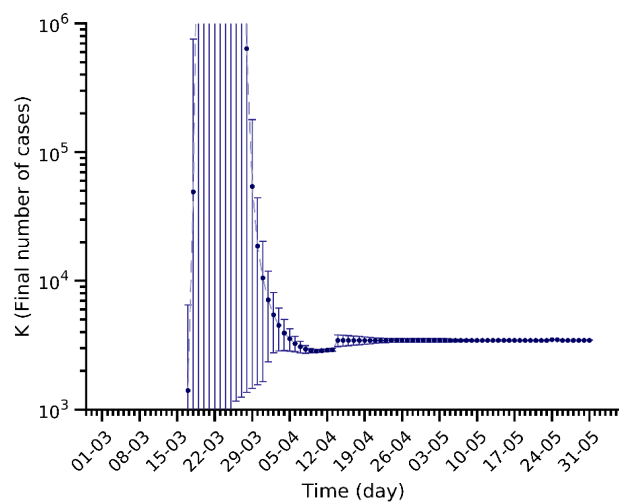
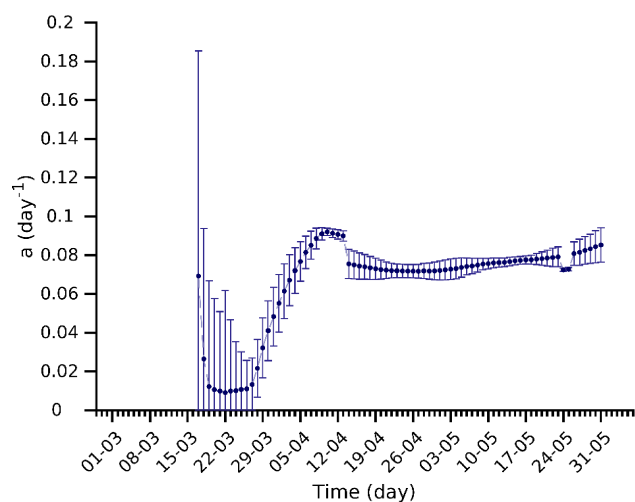
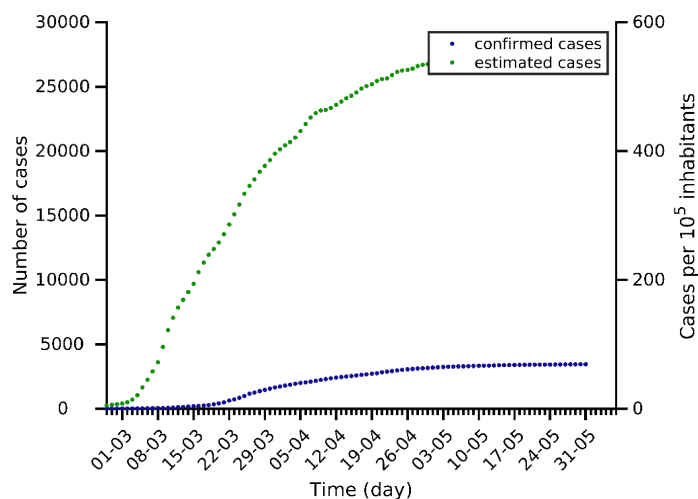
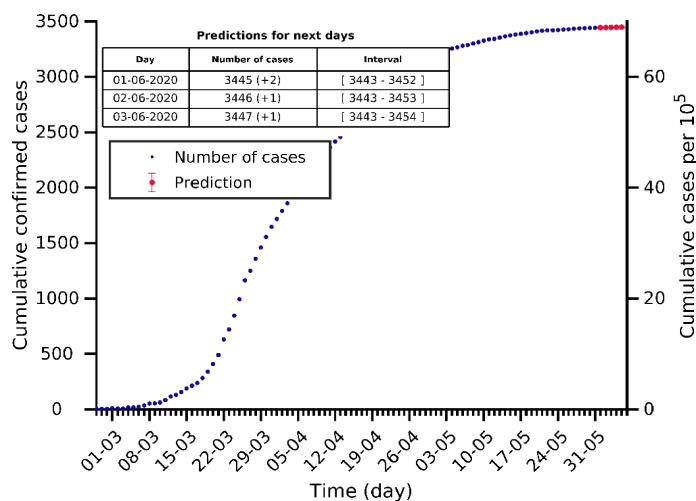
# Puglia 31-05-2020. Population: 4.0M. Current cumulated incidence: 112/10<sup>5</sup>



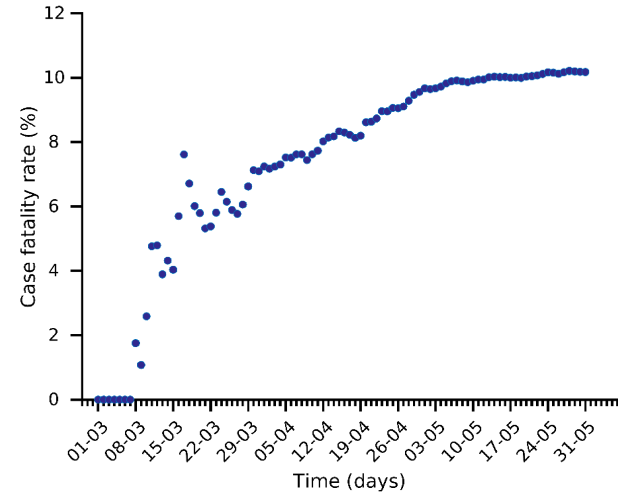
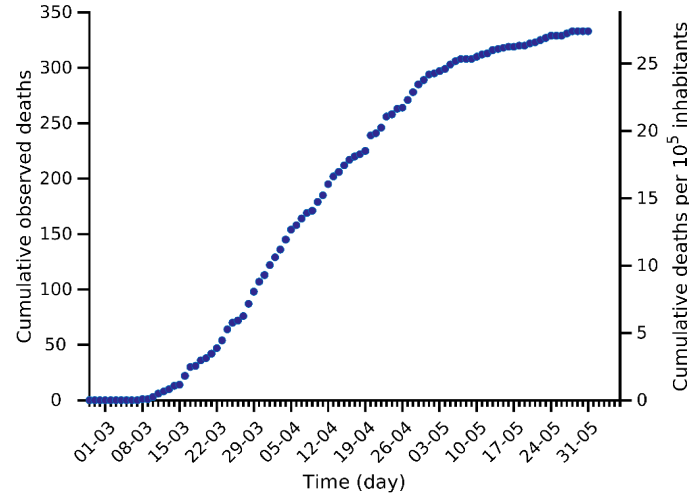
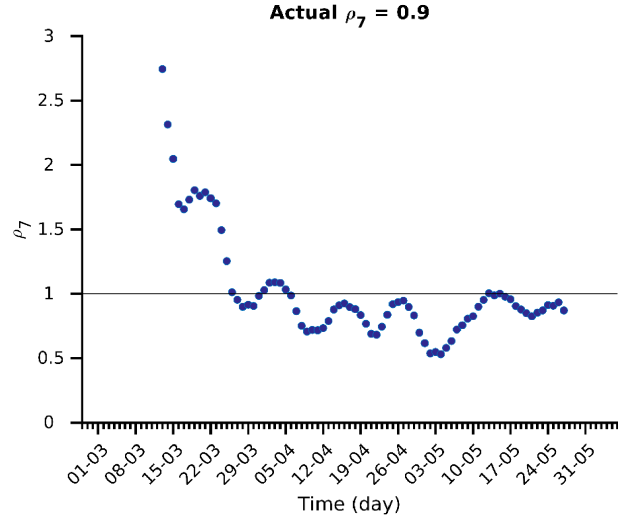
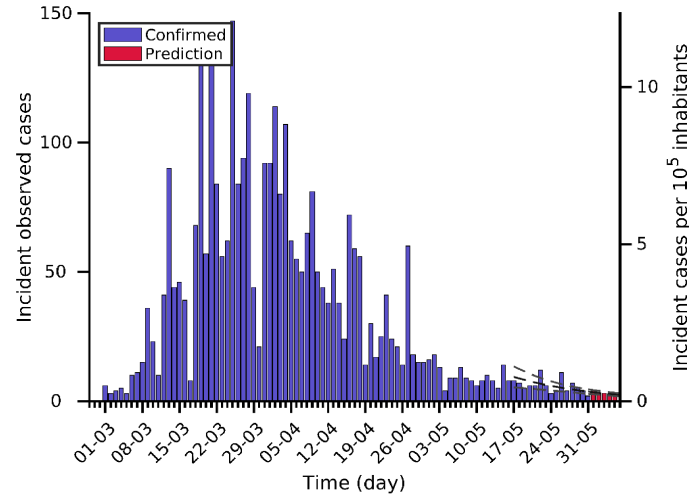
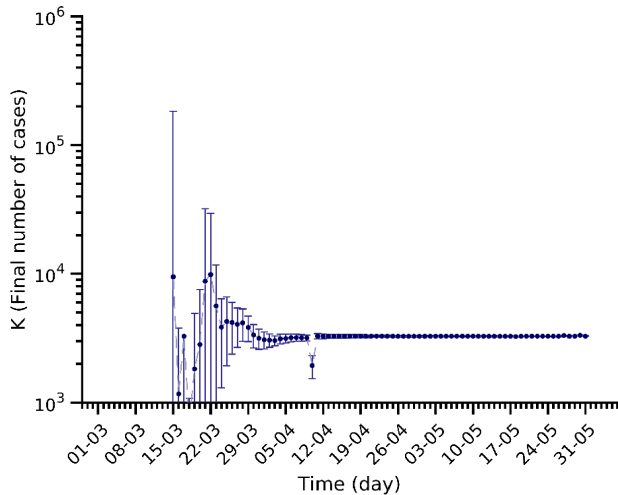
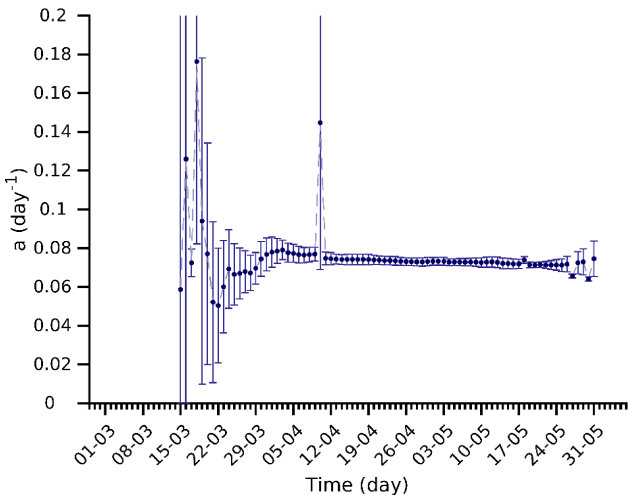
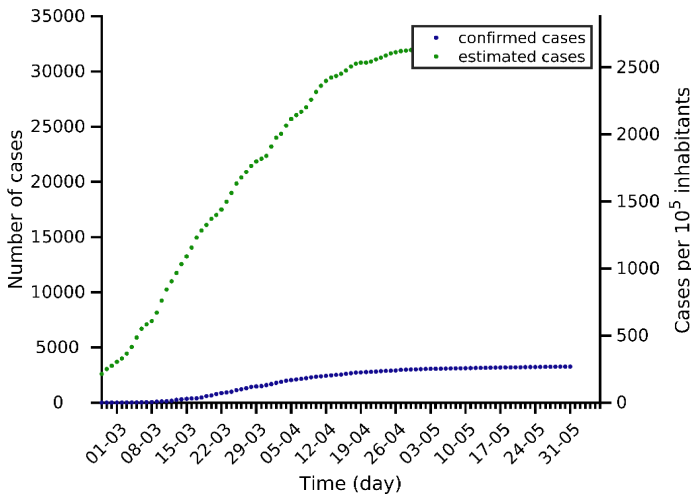
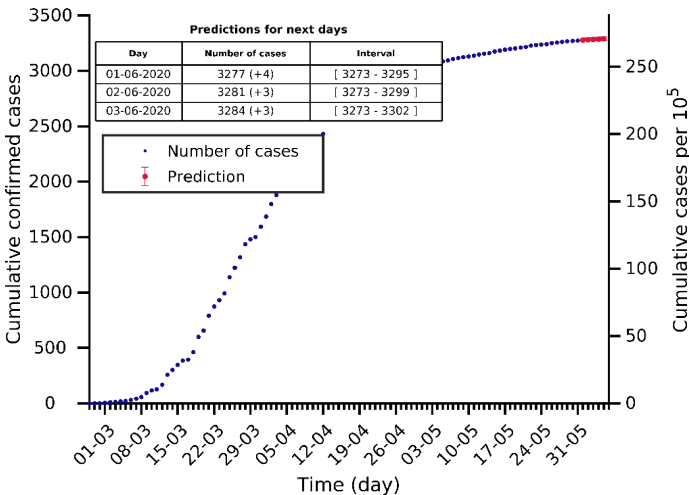
# Trento 31-05-2020. Population: 0.5M. Current cumulated incidence: 823/10<sup>5</sup>



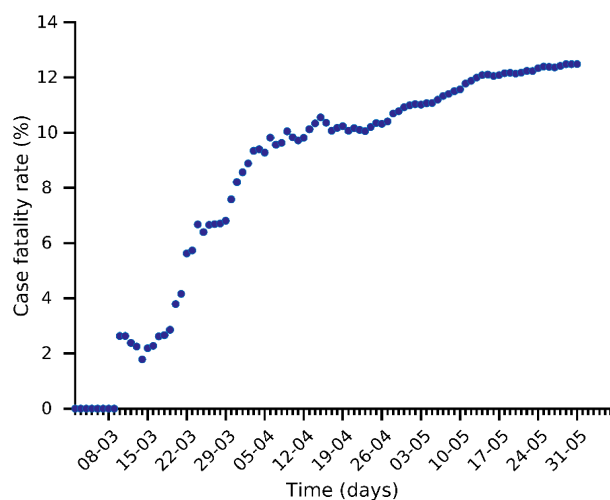
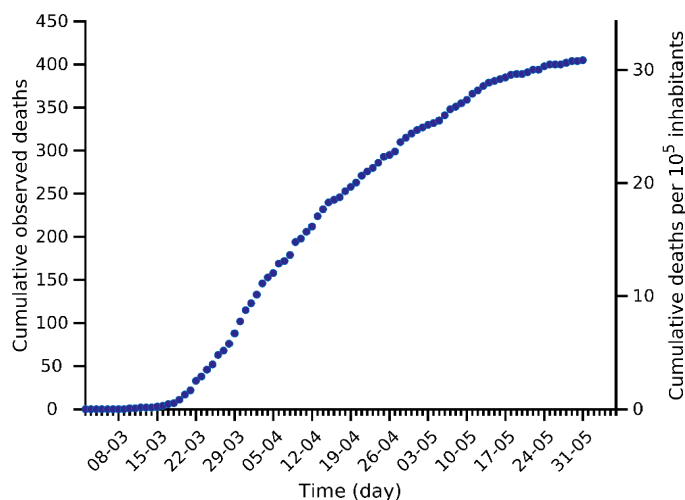
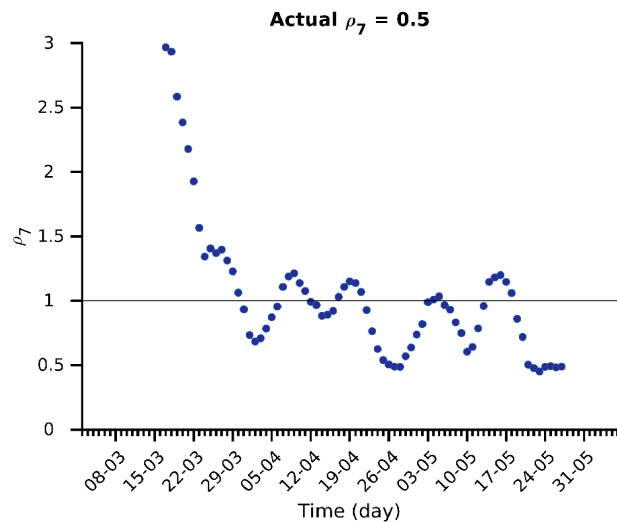
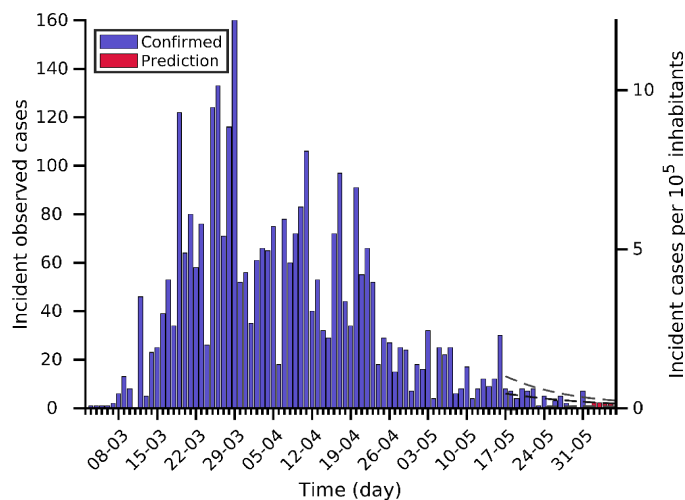
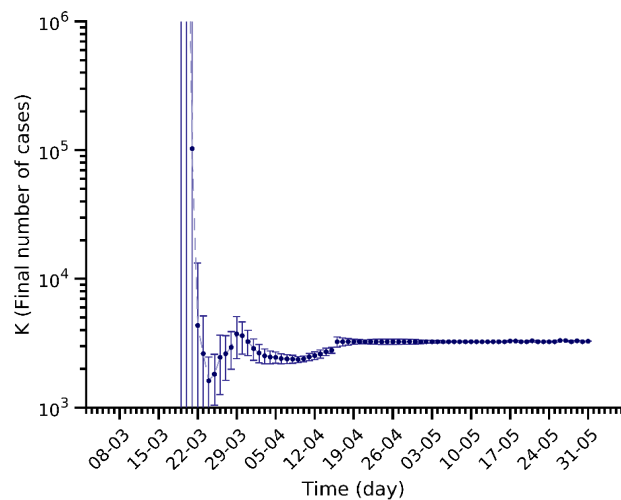
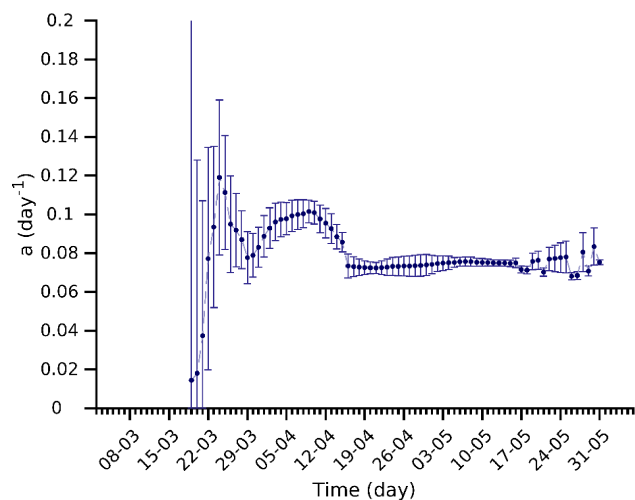
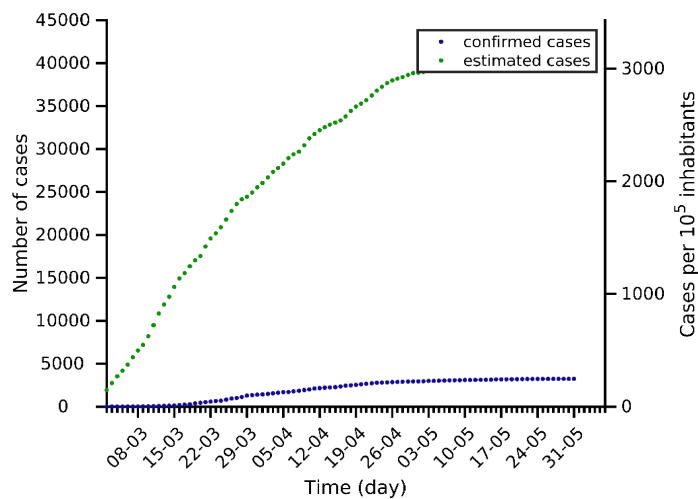
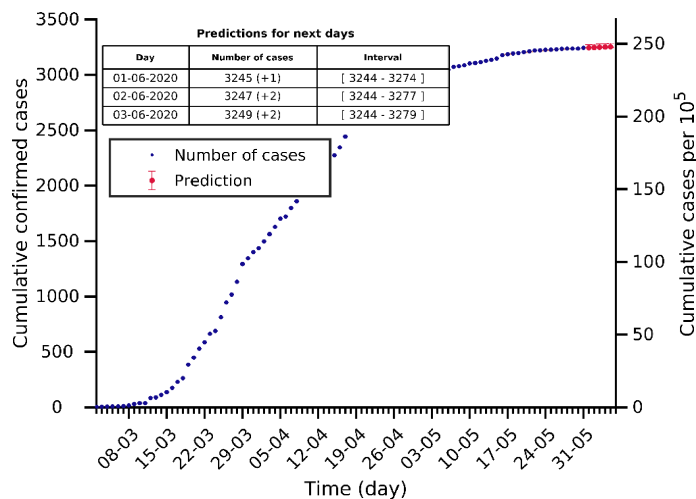
# Sicilia 31-05-2020. Population: 5.0M. Current cumulated incidence: 69/10<sup>5</sup>



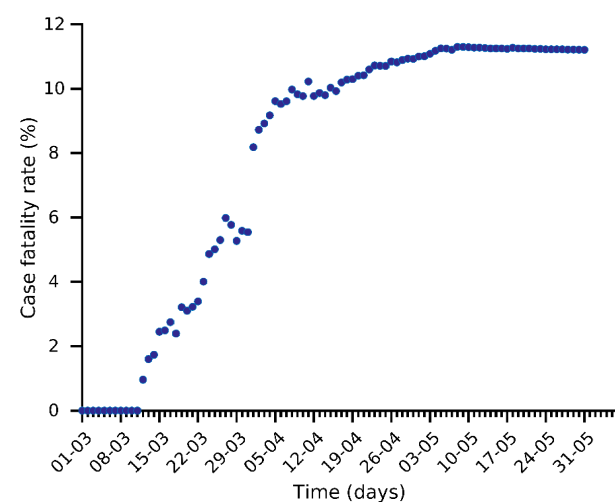
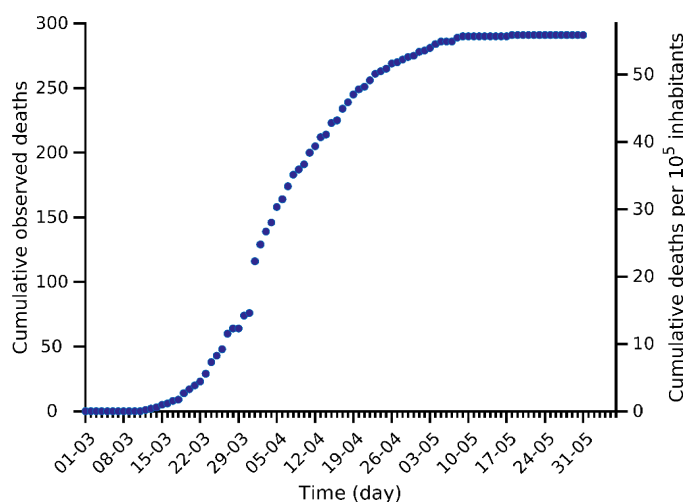
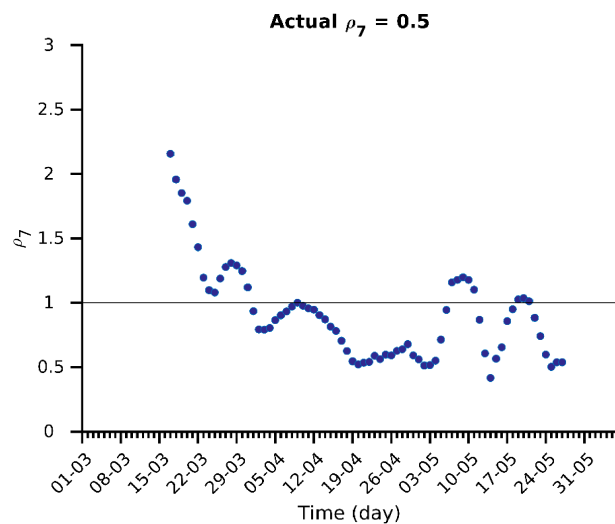
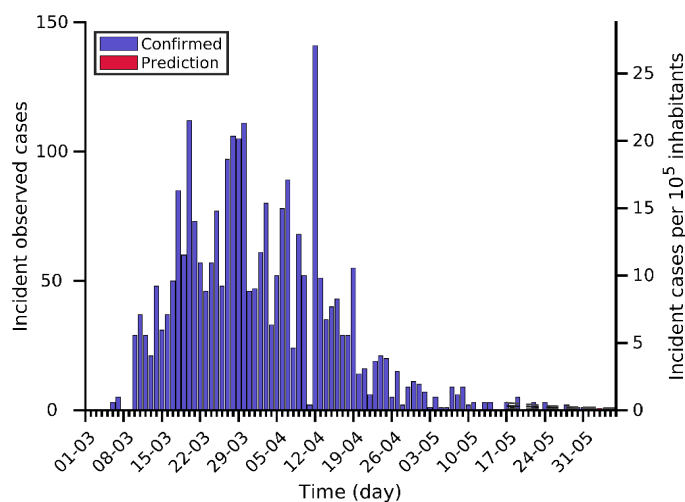
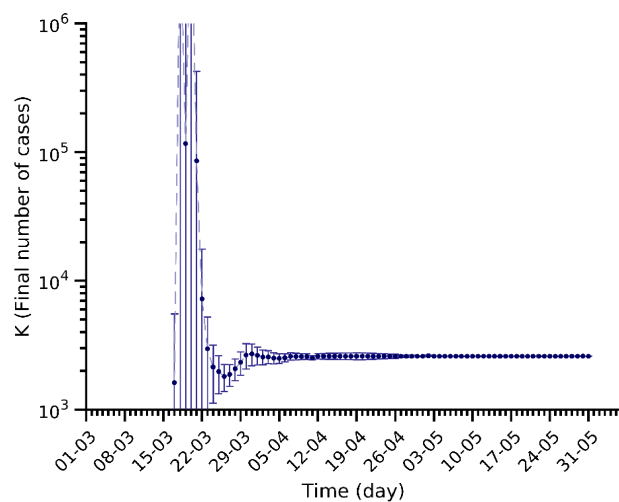
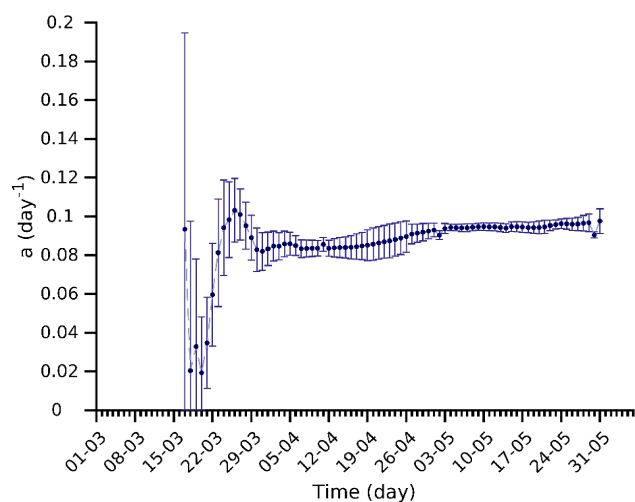
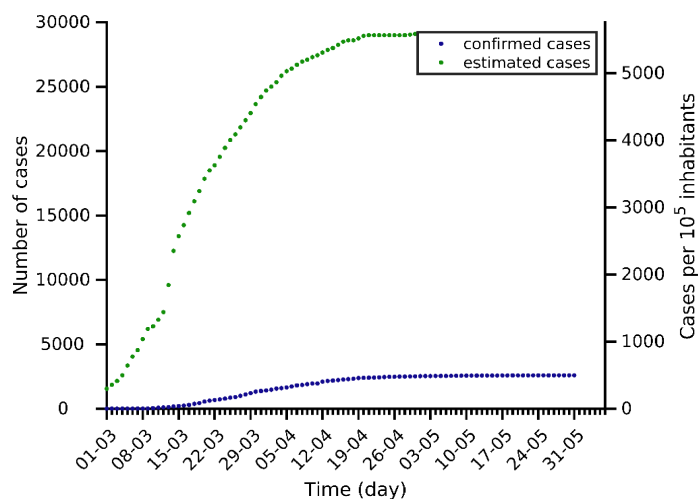
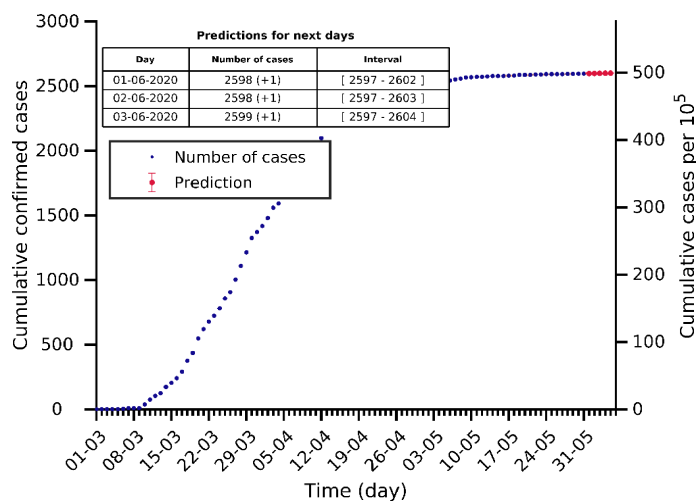
Friuli Venezia Giulia 31-05-2020. Population: 1.2M. Current cumulated incidence: 2



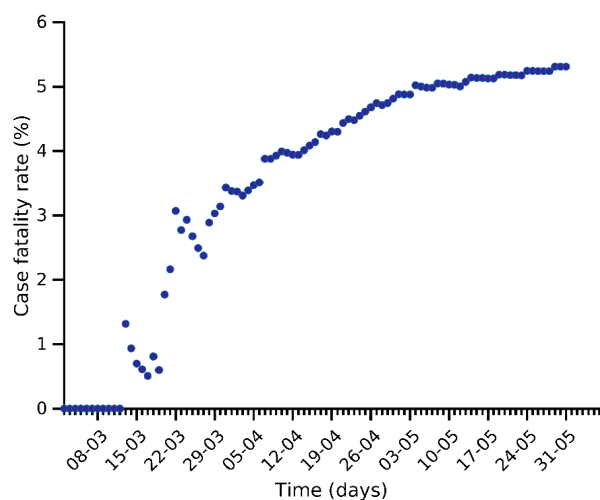
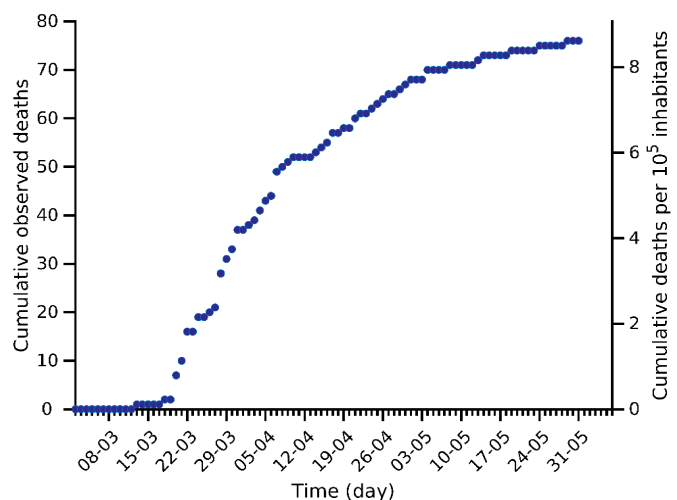
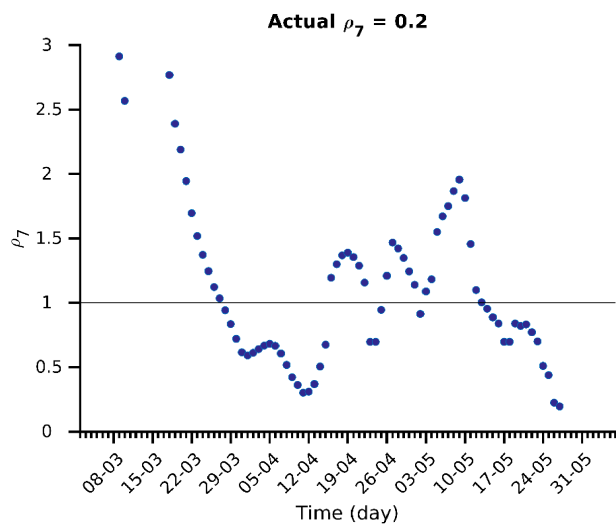
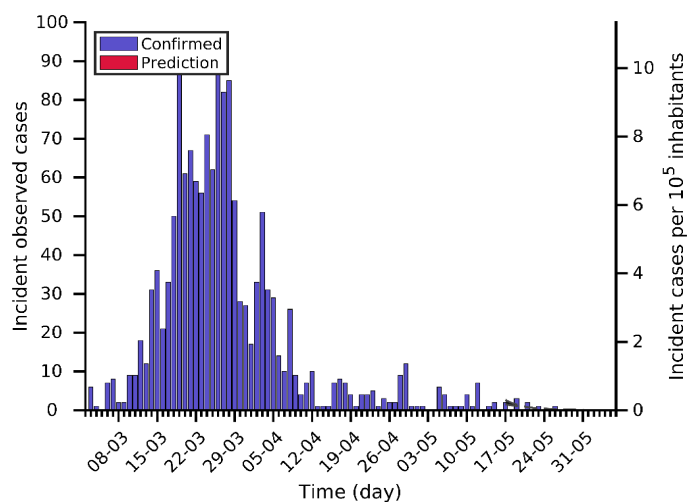
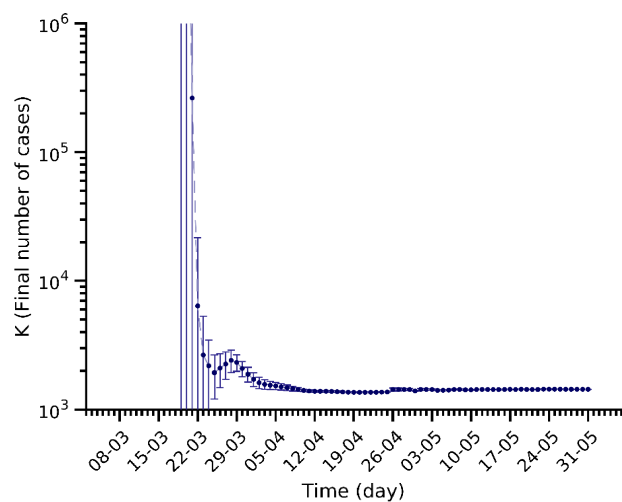
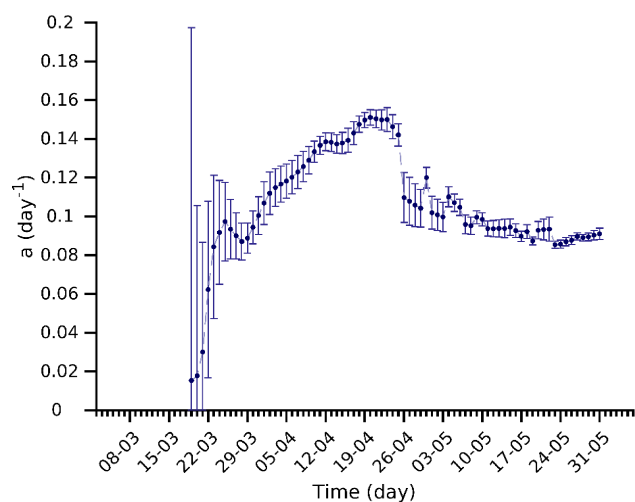
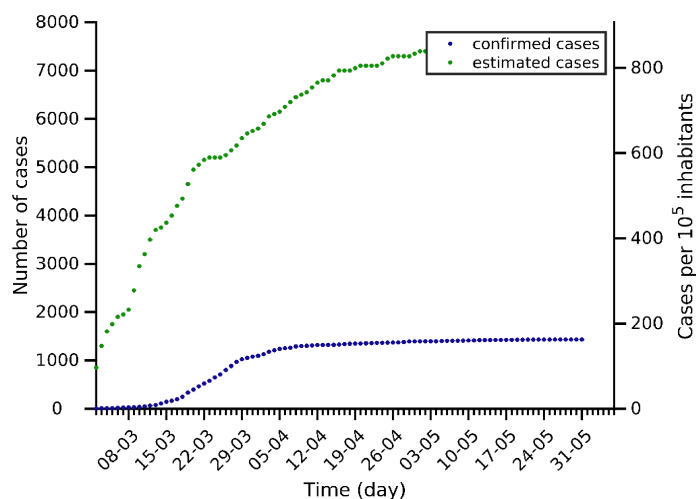
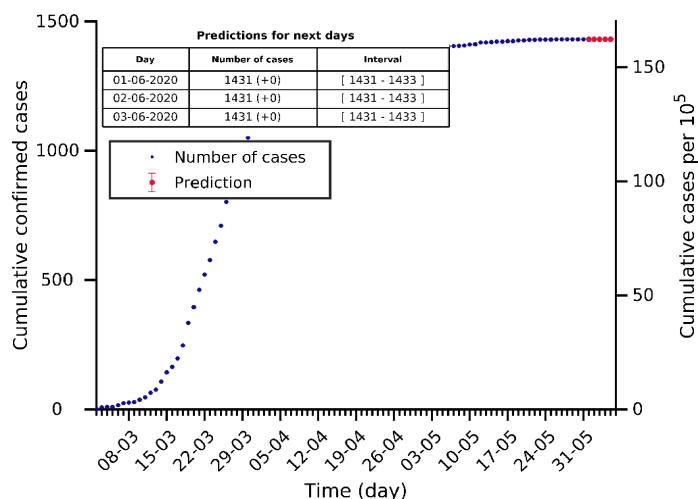
# Abruzzo 31-05-2020. Population: 1.3M. Current cumulated incidence: 247/10<sup>5</sup>



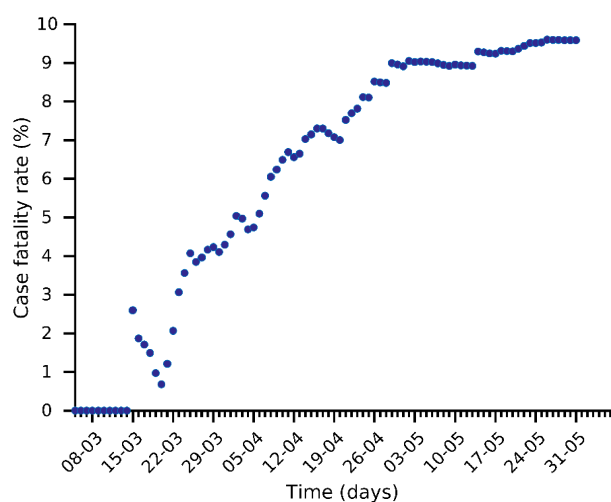
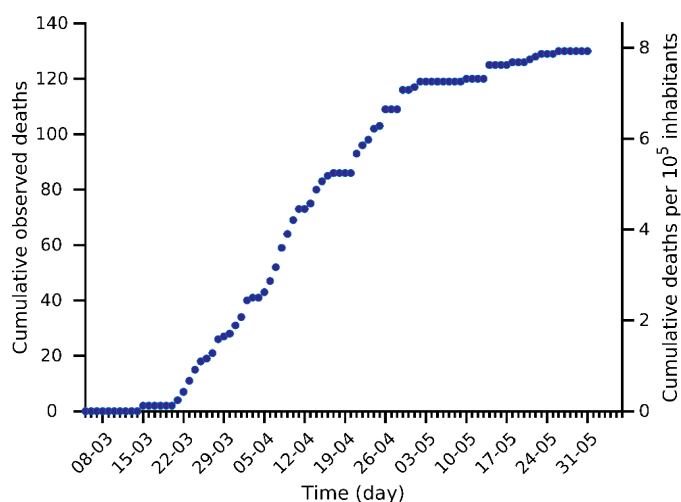
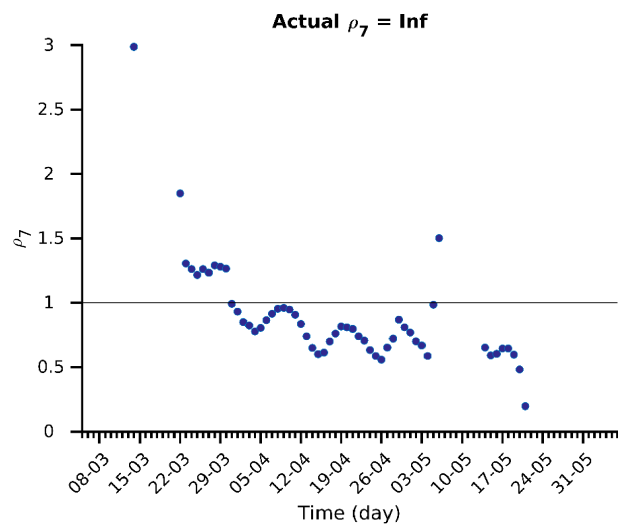
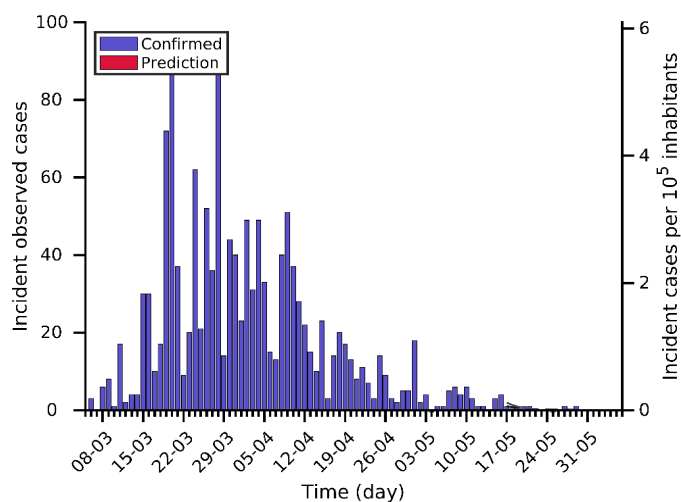
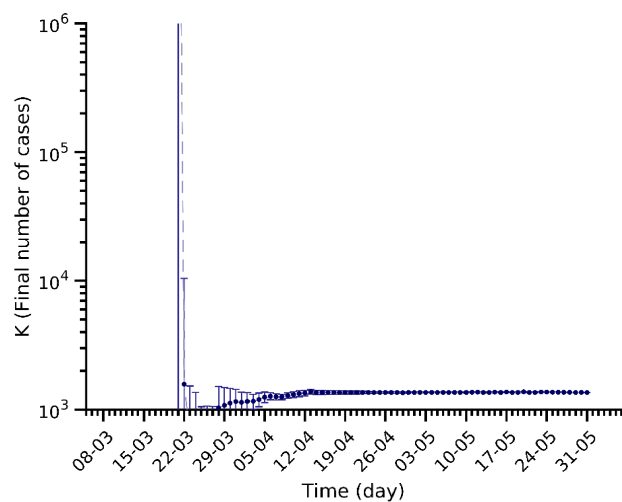
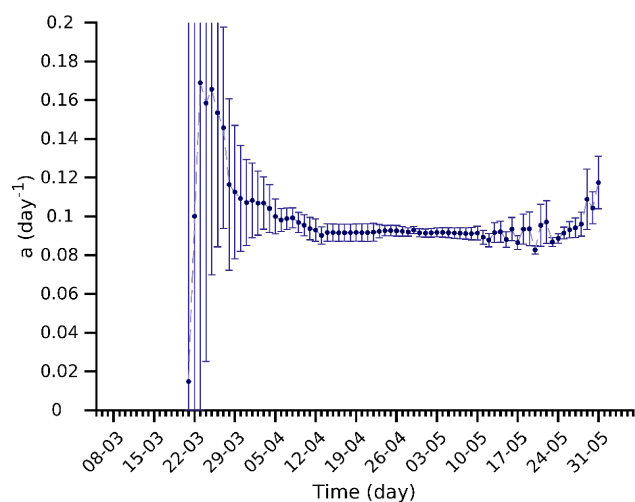
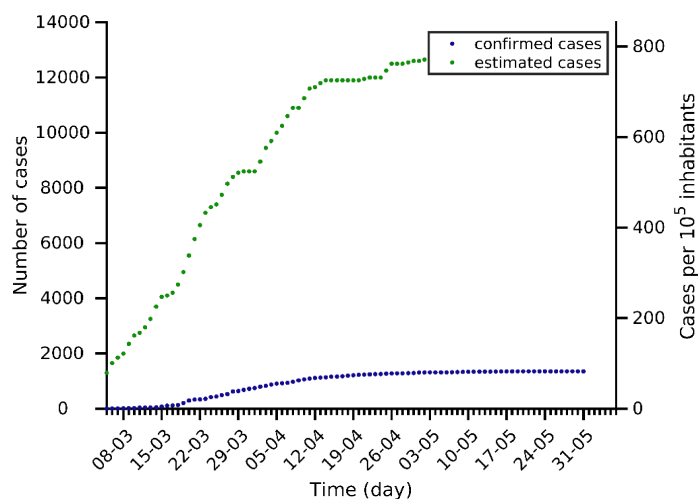
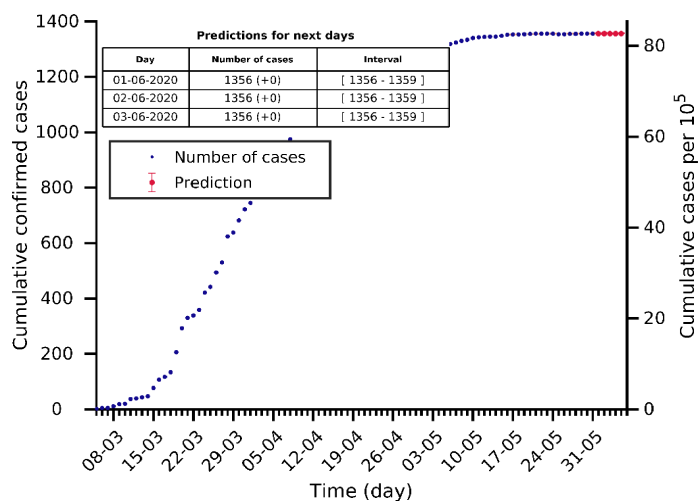
# Bolzano 31-05-2020. Population: 0.5M. Current cumulated incidence: 498/10<sup>5</sup>



# Umbria 31-05-2020. Population: 0.9M. Current cumulated incidence: 162/10<sup>5</sup>

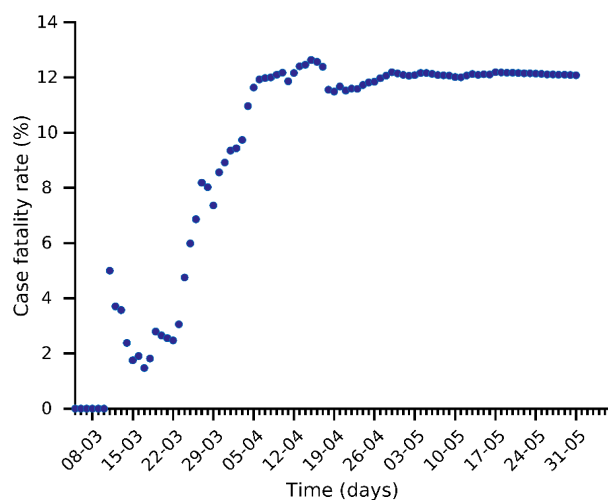
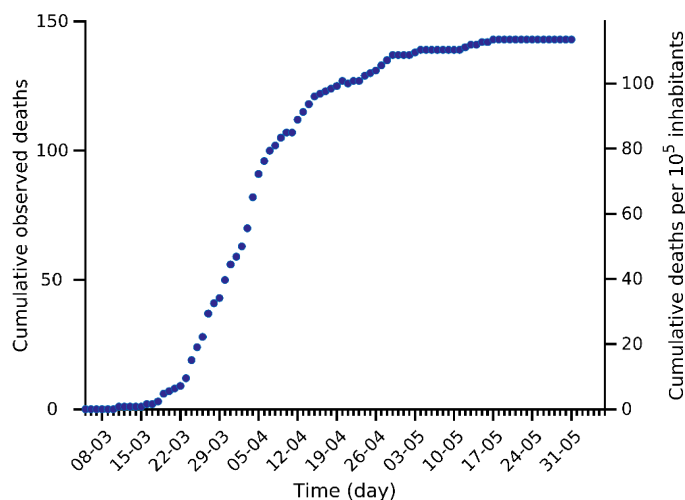
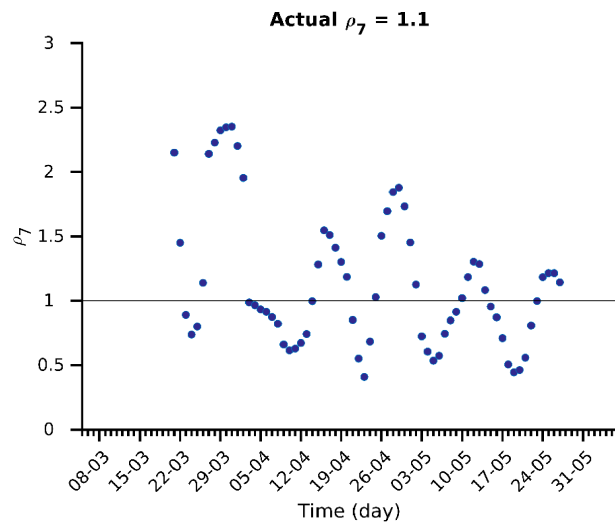
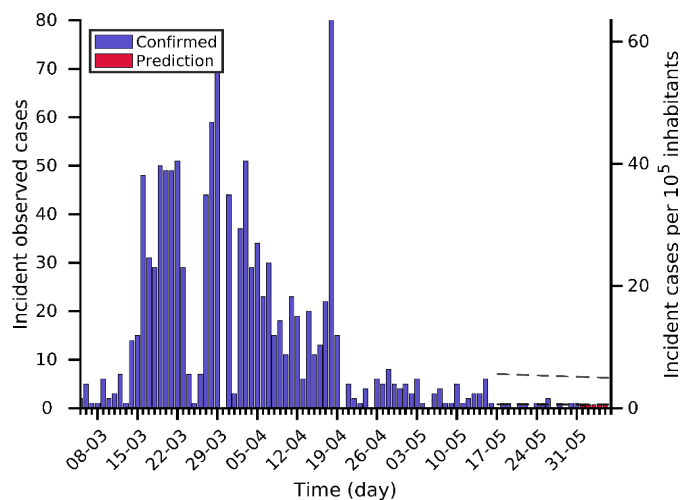
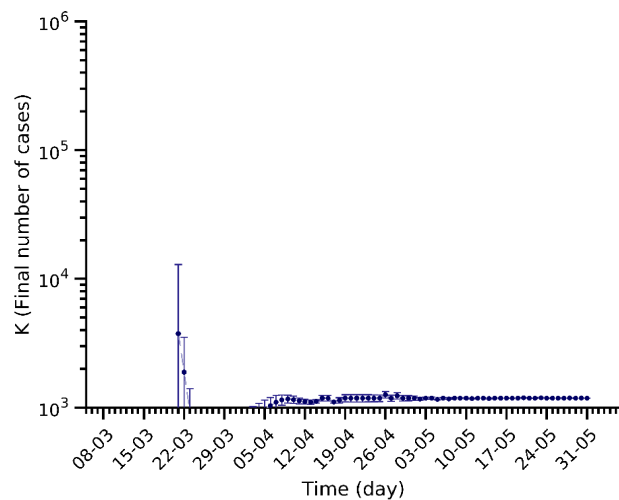
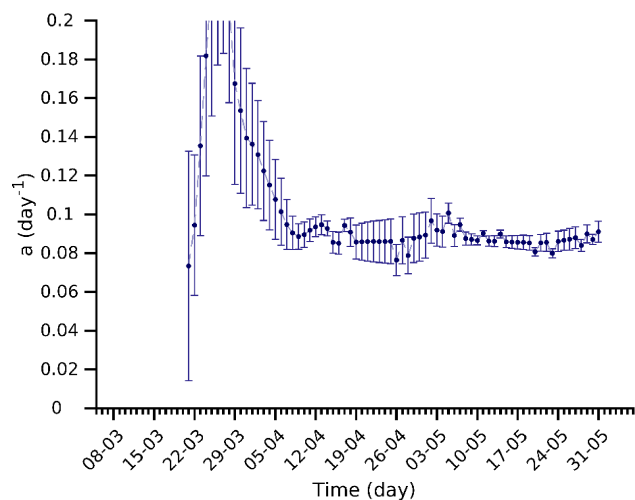
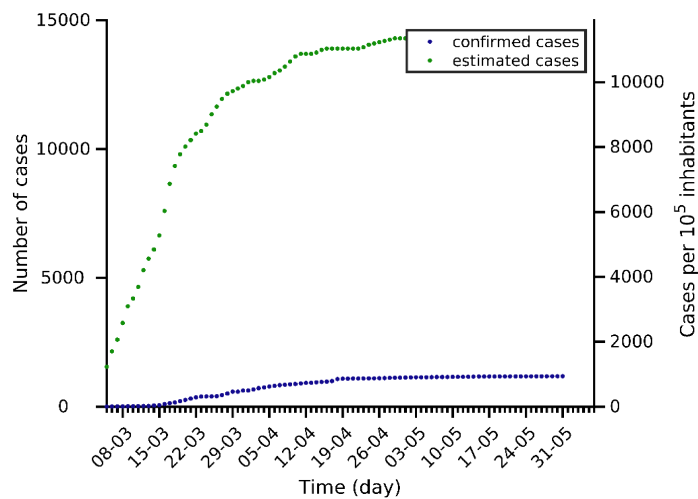
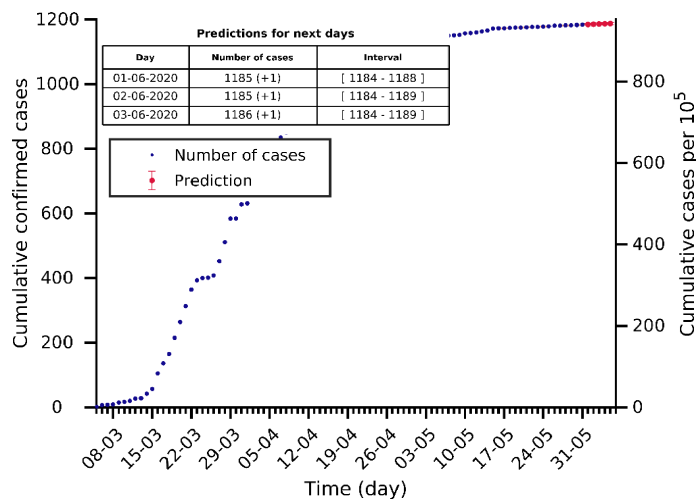


# Sardegna 31-05-2020. Population: 1.6M. Current cumulated incidence: 83/10<sup>5</sup>

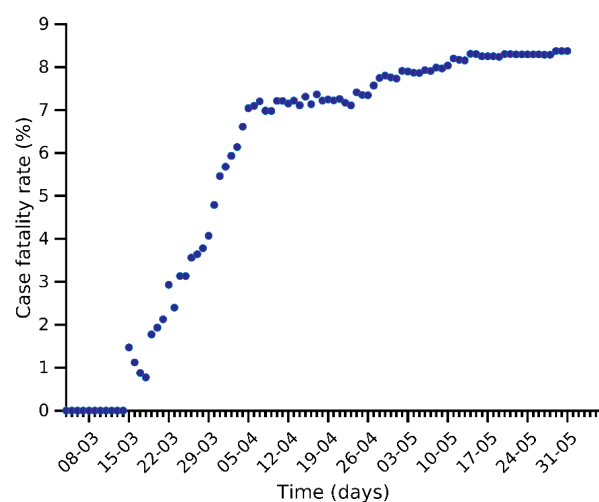
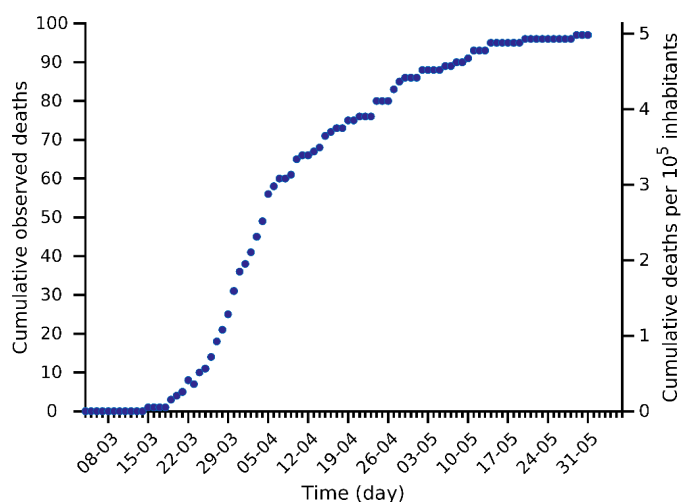
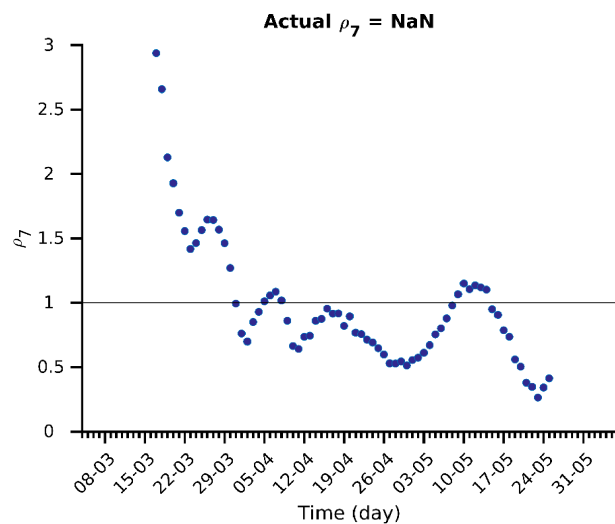
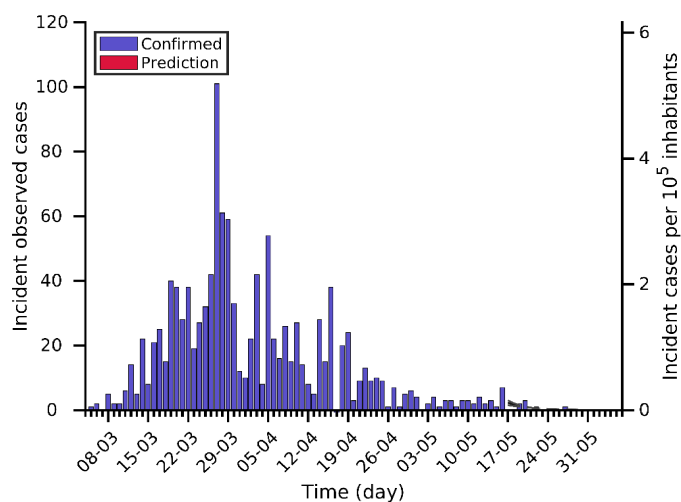
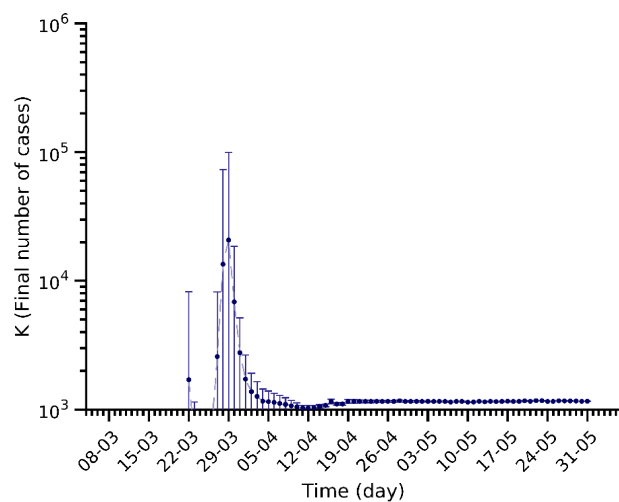
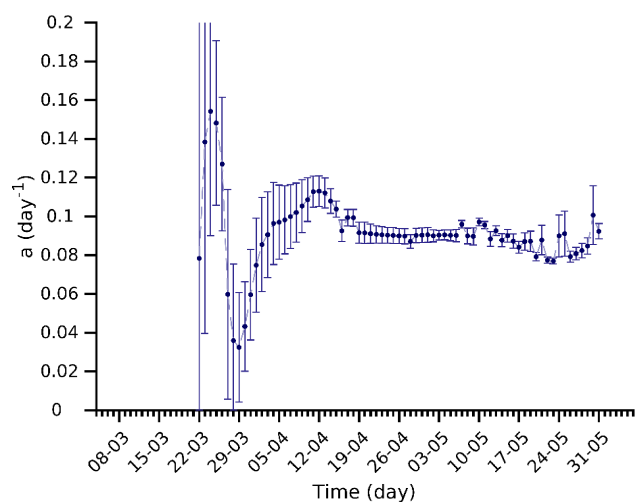
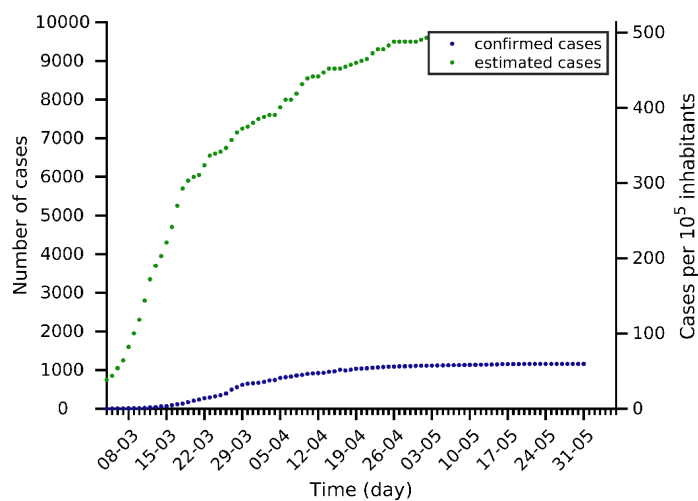
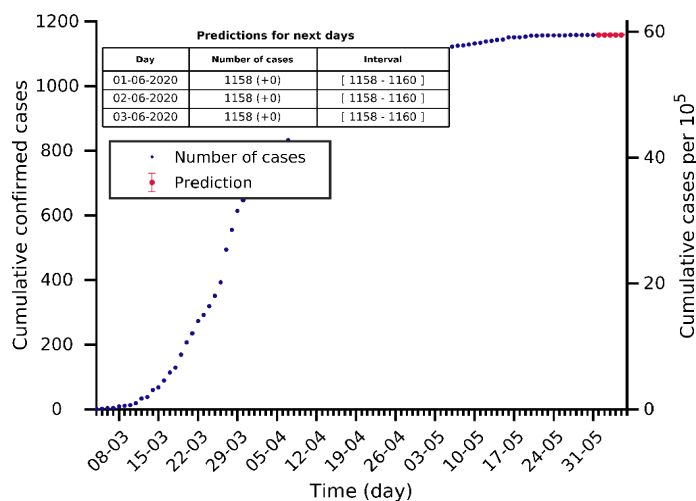




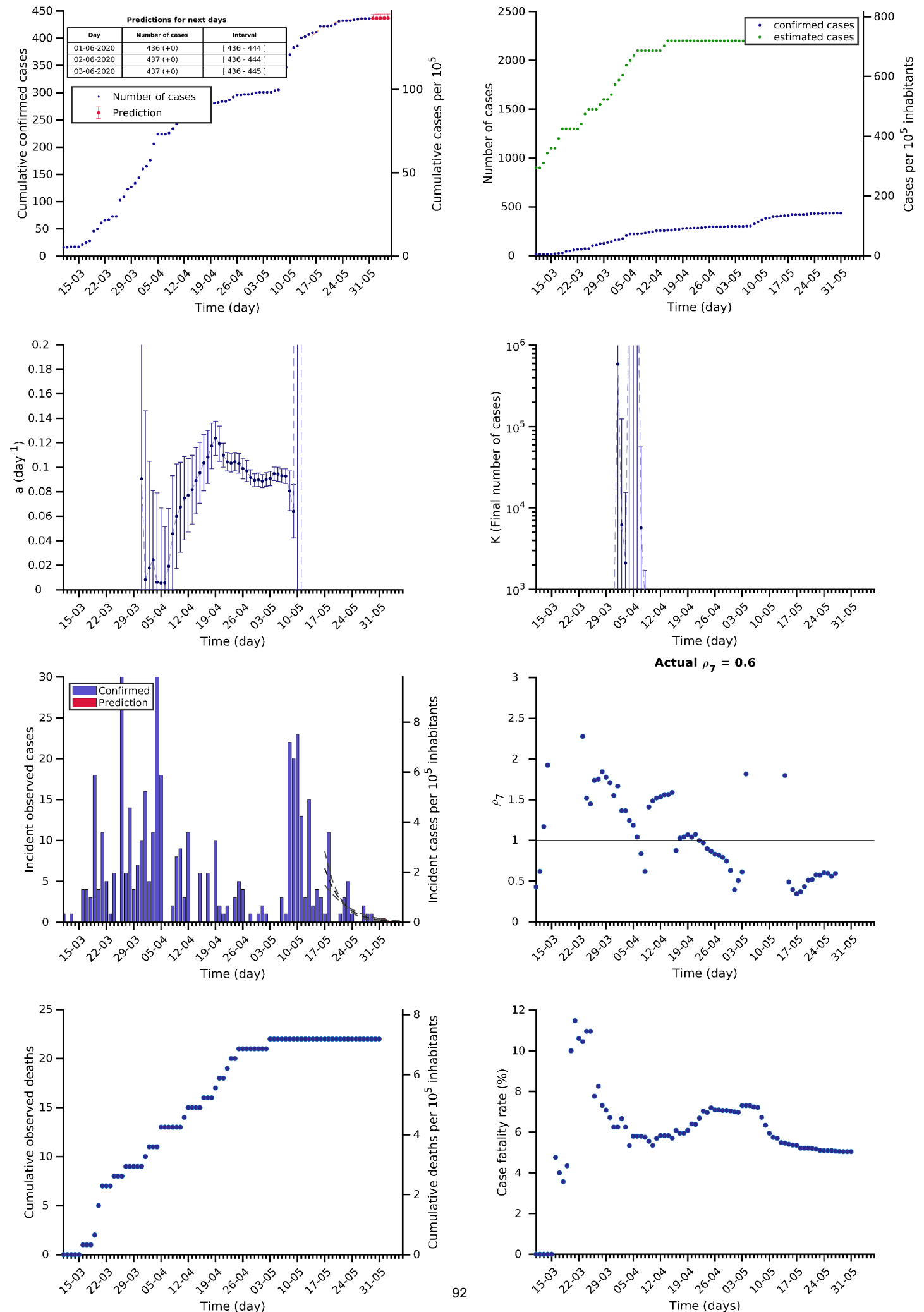
# Valle d'Aosta 31-05-2020. Population: 0.1M. Current cumulated incidence: 940/10<sup>5</sup>



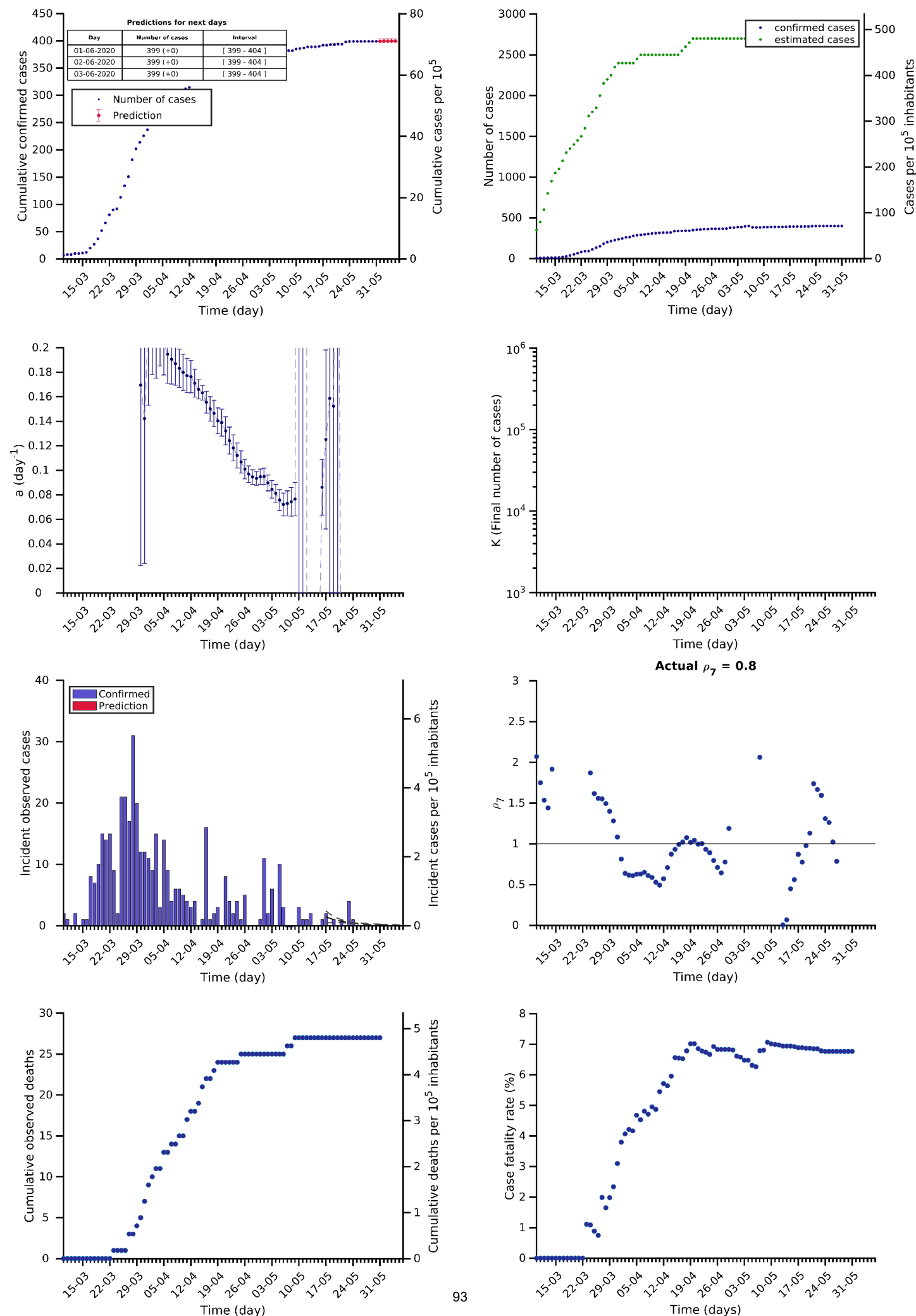
# Calabria 31-05-2020. Population: 1.9M. Current cumulated incidence: 59/10<sup>5</sup>



# Molise 31-05-2020. Population: 0.3M. Current cumulated incidence: 142/10<sup>5</sup>



# Basilicata 31-05-2020. Population: 0.6M. Current cumulated incidence: 71/10<sup>5</sup>



## Methods

## Methods

### **(1) Data source**

Data are daily obtained from World Health Organization (WHO) surveillance reports<sup>2</sup>, from European Centre for Disease Prevention and Control (ECDC)<sup>3</sup> and from Ministerio de Sanidad<sup>4</sup>. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

### **(2) Data processing and plotting**

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓  $\rho$ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ( $t-1$ ):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where  $N_{new}(t)$  is the number of new confirmed cases at day  $t$ .

### **(3) Classification of countries according to their status in the epidemic cycle**

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

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<sup>2</sup> <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

<sup>3</sup> <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

<sup>4</sup> <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>  
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

#### ***(4) Fitting a mathematical model to data***

Previous studies have shown that Gompertz model<sup>5</sup> correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where  $N(t)$  is the cumulated number of confirmed cases at  $t$  (in days), and  $N_0$  is the number of cumulated cases the day at day  $t_0$ . The model has two parameters:

- ✓  $a$  is the velocity at which specific spreading rate is slowing down;
- ✓  $K$  is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day  $t_0$  is chosen as that one at which  $N(t)$  overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters ( $a$  and  $K$ ) and the  $R^2$  of the fitting. At the initial stages the dynamics is exponential and  $K$  cannot be correctly evaluated. In fact, at this stage the most relevant parameter is  $a$ . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted  $a$  with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted  $K$  with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if  $a > 0.2 \text{ day}^{-1}$ , if  $K > 10^6$  or if the error in  $K$  overpasses  $10^6$ .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

#### ***(5) Using the model for predicting short-term tendencies***

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

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<sup>5</sup> Madden LV. Quantification of disease progression. Protection Ecology 1980; 2: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days<sup>6</sup>;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

### ***(6) Estimating non-diagnosed cases***

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors<sup>7</sup> in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

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<sup>6</sup> At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

<sup>7</sup> Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3